


Parole Tributary to Church Creek Hydrologic and Hydraulic Analysis Report

Prepared for:
Anne Arundel County

Final

Date: November 30, 2017

LimnoTech
Water Environment | Scientists Engineers

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1 Introduction

As part of its National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit, Anne Arundel County is required to conduct long term biological, chemical, and physical monitoring of two developed sites. In 1998 the Church Creek watershed was selected as one of these permanent monitoring sites.

The Church Creek watershed is highly developed and contains a large percentage of impervious surface. The watershed is mostly commercial and includes several large developments, including the Annapolis Towne Centre, Festival at Riva Shopping Center, and the Annapolis Harbour Center. The watershed has been undergoing redevelopment, including the reconstruction of Parole Plaza into the Annapolis Towne Centre, which has led to the addition of various BMPs throughout the site.

The purpose of this report is to determine the effect of the 1-, 2-, 10-, and 100-year design storms on the stream bed. This was done by using SWMM to model the hydrology of the watershed, and HEC-RAS to model the stream hydraulics. Key results of the modeling include stream flow, shear stress, and stream velocity. The modeling results were evaluated to determine the stability of the stream during the four modeled design storms.

Several previous studies have been performed on this site to determine the effectiveness of BMP implementation in mitigating peak flows in the watershed, including a 100-year floodplain study performed by McCrone in 2001 (McCrone, 2001), and a hydrologic and hydraulic analysis done by KCI in 2010 (KCI Technologies, Inc.). This report serves as a update to these reports, and includes both hydrologic and hydraulic analysis of the creek and its watershed. This report is also required to be included with Anne Arundel County's MS4 Annual Report.

2 Hydrology

The Church Creek watershed is generally sloped from north to south and conveys water through a well-developed, commercial area via overland flow and a storm system to Church Creek and its tributary, Parole Branch. After the confluence of these two streams, the water flows east and under Solomons Island Road through a 96" CMP culvert (see Figure 1).

The hydrologic modeling was done in PCSWMM using the 2014 impervious surfaces layer provided by the County and the current SSURGO soils layer as inputs (USDA 2016). The system was modeled conservatively in that runoff generated within the watershed flows directly to the outfall or BMP that captures it. Typically, a collection system is not designed to convey very large runoff events (e.g. 100-year event), and therefore water will pond locally before flowing to the outfall or stream. However, because the size and elevations for the storm system were not known, oversized pipes were modeled to convey the flows to each outfall and BMP. Because the model directs flow to the outfall or stream through an enlarged pipe, the resulting peak flows and intensities are likely higher than would be seen during an actual precipitation event. Although additional information on the storm system could be useful to further refine these results, this conservative approach is considered appropriate for this model application.

Forty-one (41) BMPs were identified in the Church Creek watershed (Figure 1). These BMPs were identified from either the KCI report completed in 2010, or the Anne Arundel County BMP Record Review and Update project currently being conducted by LimnoTech. Fourteen (14) of these BMPs were identified as having sufficient detention to impact runoff, and were included in the model. The remaining BMPs were either too small to affect the downstream hydrograph (e.g. single family housing infiltration practices) or were designed for water quality and not detention (e.g. Baysavers), and thus they were not included in the model.

Figure 1. Church Creek Existing Conditions

Of the 14 identified BMPs, six (6) are infiltration practices, four (4) are dry ponds, three (3) are wet ponds, and one (1) is a sand filter. Drainage areas for each modeled BMP were developed using a combination of GIS data including elevation files and storm drain profiles; previous delineations done by KCI in 2010; and plan documents received from the County through the Anne Arundel County BMP Record Review

and Update project. The modeled BMP locations, their drainage areas, and the Hydrologic Soil Groups (HSGs) are shown in Figure 2 below. The HSGs classifications are used to estimate the runoff potential of various soil types. Soils classified as HSG A soils have low potential for runoff, while soils classified as HSG D have high potential. As Figure 2 shows, most of the Church Creek Watershed is classified as HSG D and will generally produce higher runoff.

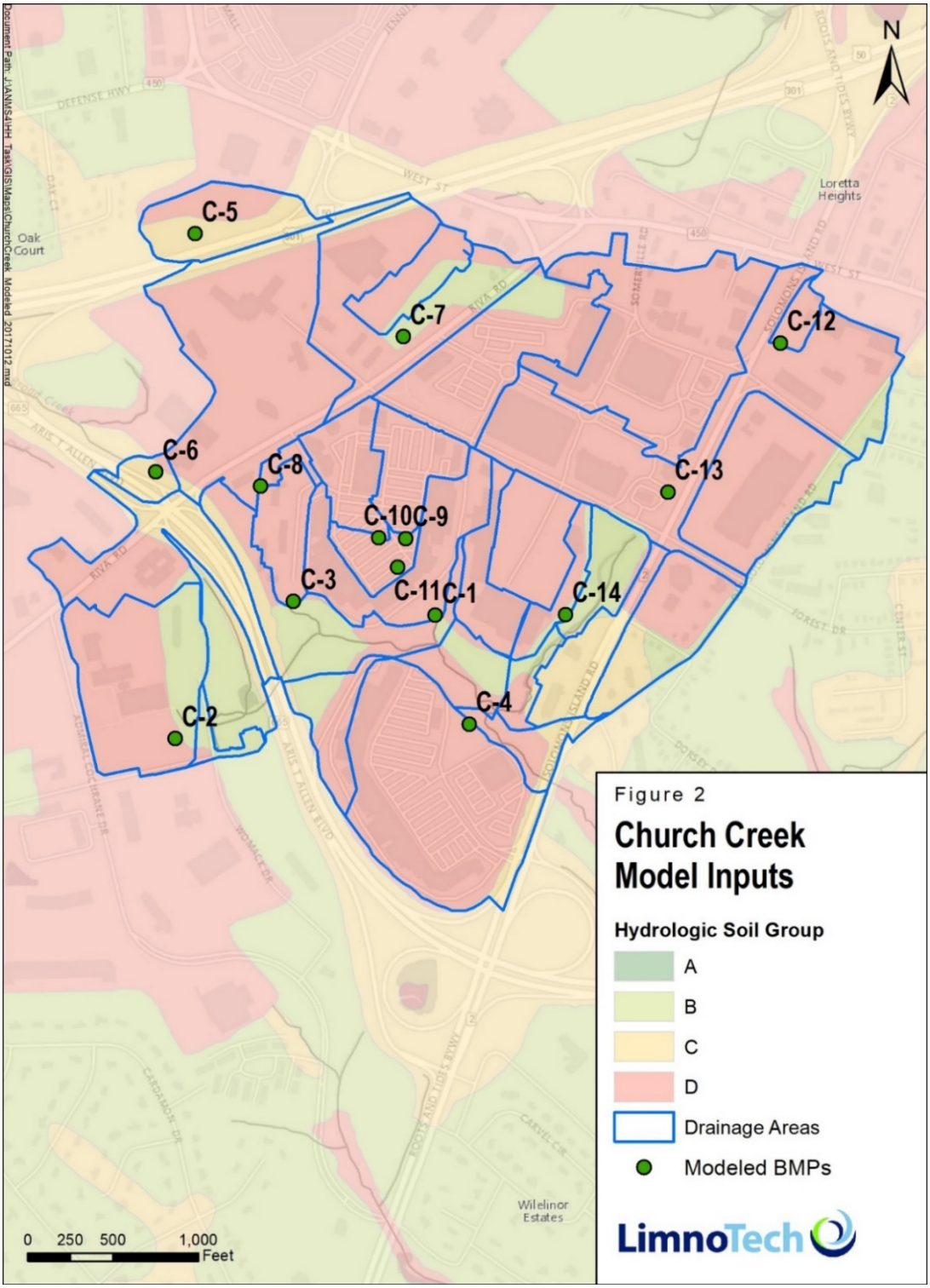

Figure 2. Church Creek Model Inputs

Available information varied for each BMP, so a breakdown of how each BMP was modeled is provided below:

BMP C-1: This wet pond was modeled as a storage unit and outfall using elevation-area and stage-discharge curves previously developed by KCI.

BMP C-2: Due to lack of information, this dry pond was assumed to treat the first 1" of rainfall based on stormwater regulations. This was done in the model by increasing depression storage of the subcatchment to 1".

BMP C-3: This dry pond was modeled using an elevation-area curve developed by KCI, and known culvert, emergency spillway, and overflow weir data from KCI that was verified through plans provided by the County.

BMP C-4: This wet pond was modeled as a storage unit and outfall using elevation-area and stage-discharge curves previously developed by KCI.

BMP C-5: This wet pond was modeled as a storage unit and outfall using elevation-area and stage-discharge curves previously developed by KCI.

BMP C-6: This infiltration BMP was modeled as a storage unit and outfall using elevation-area and stage-discharge curves previously developed by KCI.

BMP C-7: Due to lack of information, this dry pond was assumed to treat the first 1" of rainfall based on stormwater regulations. This was done in the model by increasing depression storage of the subcatchment to 1".

BMP C-8: Due to lack of information, this infiltration BMP was assumed to treat the first 1" of rainfall based on stormwater regulations. This was done in the model by increasing depression storage of the subcatchment to 1".

BMP C-9: Due to lack of information, this infiltration BMP was assumed to treat the first 1" of rainfall based on stormwater regulations. This was done in the model by increasing depression storage of the subcatchment to 1".

BMP C-10: Due to lack of information, this infiltration BMP was assumed to treat the first 1" of rainfall based on stormwater regulations. This was done in the model by increasing depression storage of the subcatchment to 1".

BMP C-11: Due to lack of information, this infiltration BMP was assumed to treat the first 1" of rainfall based on stormwater regulations. This was done in the model by increasing depression storage of the subcatchment to 1".

BMP C-12: Due to lack of information, this dry pond was assumed to treat the first 1" of rainfall based on stormwater regulations. This was done in the model by increasing depression storage of the subcatchment to 1".

BMP C-13: Due to lack of information, this sand filter was assumed to treat the first 1" of rainfall based on stormwater regulations. This was done in the model by increasing depression storage of the subcatchment to 1".

BMP C-14: Due to lack of information, this infiltration BMP was assumed to treat the first 1" of rainfall based on stormwater regulations. This was done in the model by increasing depression storage of the subcatchment to 1".

3 Hydraulics

LimnoTech surveyed cross sections along Church Creek for the HEC-RAS model in September 2017. The focus of the survey was on defining the main channel flow path and the immediate floodplain. The elevation for the extended floodplains and overbank areas were taken from the LiDAR derived surface that was received from the County (Anne Arundel County 2017). Versar also has stream cross sections recorded in 2017 for a geomorphic study, and these cross sections were also used for the HEC-RAS model. In order to import the cross sections into HEC-RAS, cross sections were first taken from the LiDAR surface and then compared to the surveyed cross sections from LimnoTech and Versar. The cross sections were then adjusted to reflect the surveyed portion of the channel which helped to define the low flow channel more precisely. Generally, there was little difference between the LiDAR cross sections and the surveyed cross sections. In areas where the low flow channel was not picked up by the LiDAR, small modifications were made in HEC-RAS to reflect the low flow channel. The Solomons Island Road stream crossings was surveyed as part of the KCI study and these elevations and details were used directly in the HEC-RAS model. The final modeled cross sections are shown in Figure 3.

Manning's n values which describe the flow roughness of the stream were assigned based on field notes and photographs of the site. For the main channel, an "n" value of 0.045, which corresponds to a main channel with vegetation, some pools, and stones/obstructions (Chow 1959), was used. Overbank "n" values of 0.08 - which corresponds to floodplains with light brush and trees - were used (Chow 1959).

A steady flow file was created to define the flows and model boundary condition. The 1, 2, 10, and 100-year discharges from the SWMM model were used to develop this steady flow file. The downstream slope of the channel (0.01 ft/ft), was entered into the model as the downstream "normal depth" boundary condition. The "subcritical" flow regime was selected because this is a low gradient stream.

The discharges from SWMM that were modeled in HEC-RAS are shown in Table 1.

Table 1. SWMM discharges used in HEC-RAS (cfs)

River Station	1-year	2-year	10-year	100-year
2442	183	247	371	521
1664	280	374	558	781
942	539	723	1247	1833
654	548	734	1263	1856

The modeled BMPs provide volume and peak flow reduction, but are much less effective in doing so for larger storms. During small storms up to an inch, the BMPs are not at capacity, meaning that they can provide mitigation throughout the storm. Once the BMPs fill, however, they provide little to no flow mitigation and the outflow is equal to the inflow. Additionally, these large 10- and 100-year design storms are so intense that the BMPs fill in minutes, reducing their overall effectiveness to mitigate the impacts of these larger events.

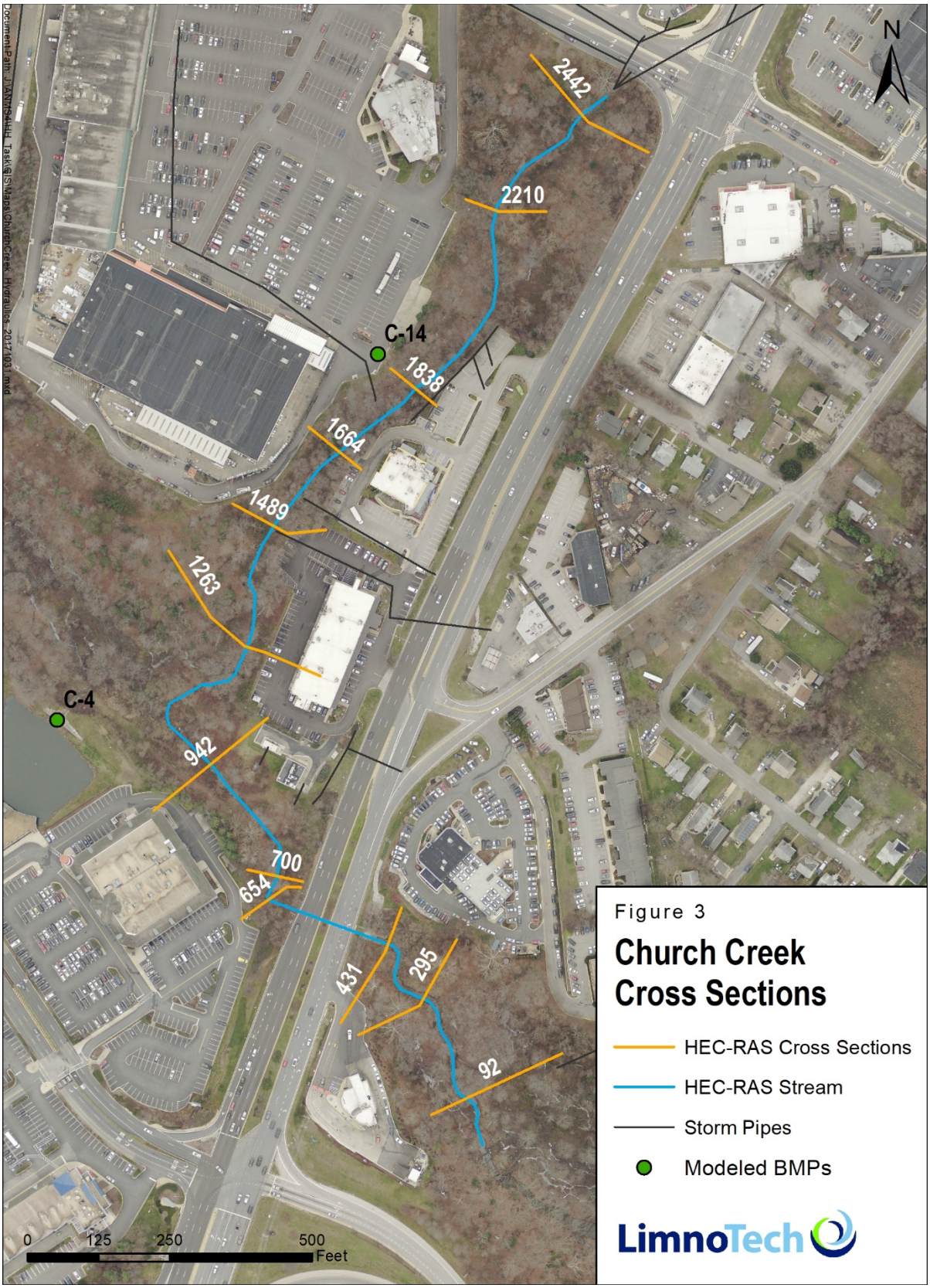

Figure 3. Church Creek Modeled Cross Sections

4 Results

To assess a stream's stability, the velocity and shear stress are both used to evaluate the erosive forces within the stream channel. The maximum permissible velocity of a stable silty loam stream channel is 3.0 ft/s (ASCE 1926). The critical bed shear stress in the channel should be less than 0.03 lb/ft^2 (USGS 2008) for similar soil conditions. It is important to note that all results presented below are values for the peak of the hydrograph and do not occur throughout the event. Therefore, if the velocity or shear stress is exceeded it does not necessarily mean the stream is not in equilibrium. If normal sediment transport conditions exist, the eroded areas will be replenished from upstream areas and the stream will remain stable.

1 year Recurrence Interval Event

The 1-year storm does not overtop Solomons Island Road. The channel velocities range from 7-9 ft/s at the upstream end of the reach where the slope is steepest to less than 3 ft/s at the downstream reach where the channel slope is more gradual. The shear stress in the channel varies throughout the reach but is highest where the velocity is the greatest. See Table 2 for hydraulic model results.

Table 2. HEC-RAS Results for 1-Year Recurrence Interval

River Station	Maximum W.S. Elevation	Average Peak Channel Velocity	Maximum Shear Stress, Channel
	(ft)	(ft/s)	(lb/sq/ft)
2442	33.96	7.96	2.80
2210	30.37	3.74	0.58
1838	28.82	4.69	0.84
1664	26.72	9.07	3.12
1489	23.48	9.31	3.50
1263	21.77	1.59	0.09
942	21.73	1.39	0.06
700	21.59	3.13	0.28
654	21.36	4.11	0.57
595	Solomons Island Road		
431	14.10	9.23	3.30
295	12.23	8.44	2.80
92	10.28	5.53	1.35

2 year Recurrence Interval Event

The 2-year storm also does not overtop the crossing although flow is being restricted by the culvert. The velocity in the channel has a similar range to the 1-year storm with a slight increase. The water surface elevations do increase as expected for the 2-year recurrence interval.

Table 3. HEC-RAS Results for 2-Year Recurrence Interval			
River Station	**W.S. Elevation**	**Average Channel Velocity**	**Shear Stress, Channel**
	(ft)	**(ft/s)**	**(lb/sq/ft)**
2442	34.35	8.80	3.24
2210	30.85	3.70	0.54
1838	29.52	4.92	0.87
1664	27.01	10.90	4.39
1489	26.28	5.42	0.95
1263	26.51	0.66	0.01
942	26.50	1.04	0.03
700	26.45	2.10	0.11
654	26.39	2.61	0.20
595	Solomons Island Road		
431	14.78	9.97	3.65
295	12.53	10.15	3.93
92	10.53	5.94	1.51

10 year Recurrence Interval Event

For the 10-year storm event, the Solomons Island culvert is at capacity and the road is overtopped. The velocities and shear stresses in the channel are much lower in this scenario as flow is backed up behind the crossings, creating slow moving riverine conditions.

Table 4. HEC-RAS Results for 10-Year Recurrence Interval			
River Station	**W.S. Elevation**	**Average Channel Velocity**	**Shear Stress, Channel**
	(ft)	**(ft/s)**	**(lb/sq/ft)**
2442	35.10	9.64	3.58
2210	34.31	1.71	0.09
1838	34.16	2.54	0.18
1664	34.02	3.85	0.39
1489	34.01	2.48	0.15
1263	34.05	0.35	0.00
942	34.04	0.83	0.01
700	34.02	1.81	0.07
654	34.00	1.91	0.09
595	Solomons Island Road		

Table 4. HEC-RAS Results for 10-Year Recurrence Interval			
River Station	W.S. Elevation	Average Channel Velocity	Shear Stress, Channel
	(ft)	(ft/s)	(lb/sq/ft)
431	16.18	11.64	4.55
295	14.02	9.62	3.13
92	11.09	6.82	1.85

100 year Recurrence Interval Event

During the 100-year event, the culvert is again at capacity and the road is overtopped. Velocities are much slower in the channel because the water is backed up but erosion may occur just downstream of the crossing.

Table 5. HEC-RAS Results for 100-Year Recurrence Interval			
River Station	W.S. Elevation	Average Channel Velocity	Shear Stress, Channel
	(ft)	(ft/s)	(lb/sq/ft)
2442	35.86	10.14	3.69
2210	35.29	1.97	0.11
1838	35.11	3.07	0.25
1664	34.90	4.80	0.58
1489	34.90	3.04	0.22
1263	34.95	0.46	0.00
942	34.94	1.13	0.03
700	34.90	2.52	0.13
654	34.87	2.56	0.16
595	Solomons Island Road		
431	17.7	11.68	4.25
295	14.69	10.78	3.77
92	11.61	7.58	2.17

5 Discussion

The modeled results do show velocity and shear stress thresholds being exceeded in some locations. From our field observations, there was evidence of bank erosion and channel instability. The Parole Tributary of Church Creek is a relatively steep gradient stream (>1% slope) in a confined stream valley with little floodplain area. The contributing drainage area is highly impervious and runoff is likely flashy and immediate. Because of this hydrology and the lack of floodplain area, the stream energy remains confined in the channel and is causing erosion and instability. Additionally, yearly geomorphic monitoring from 2010 to 2017 has been performed in Parole Tributary and Church Creek and results from this monitoring corroborate the findings presented in this report. The monitoring found the conditions in the area have not improved over the years and remain in a degraded and impaired condition. Although the stream channel has been stabilized in some areas from restoration activities, the effects have yet to be broadly realized over the length of the stream.

6 References

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Chow, V.T. 1959. *Open Channel Hydraulics.* McGraw-Hill, New York.

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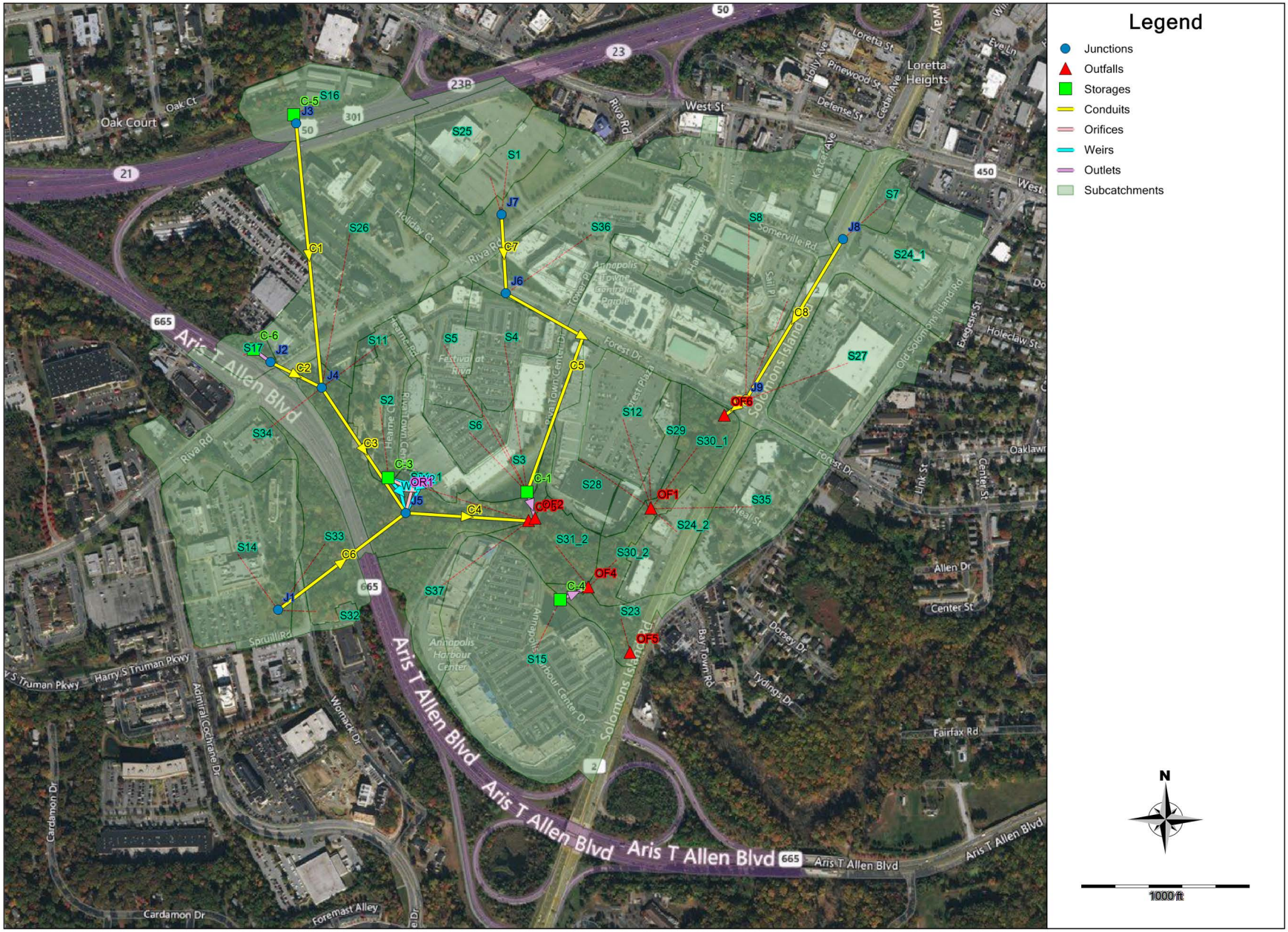
McCrone. 2002. *West County Library Stormwater Management Report.* July 2002.

USDA. 2016. Soil Survey Map of Anne Arundel County, SSURGO. Accessed through https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm.

USGS. 2008. Scientific Investigations Report 2008-5093. Table 7.

Appendix A. SWMM Model Files


Legend
Junctions
Outfalls
Storages
Conduits
Orifices
Weirs
Outlets
Subcatchments
N
1000 ft
Aris T Allen Blvd
Solomons Island Rd
Riva Rd
West St
Loretta Heights
Oak Court
Annapolis Harbour Center
Annapolis Towne Centre at Parole
Festival at Riva
Riva Town Center
Harbour Center
J1
J2
J3
J4
J5
J6
J7
J8
J9
C-1
C-3
C-4
C-5
C-6
C1
C2
C3
C4
C5
C6
C7
C8
OR1
OR2
OF1
OF4
OF5
OF6
S1
S2
S3
S4
S5
S6
S7
S8
S11
S12
S14
S15
S16
S17
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S34
S35
S36
S37
665
50
23
23B
301
21
450
Cardamon Dr
Foremast Alley
Fairfax Rd
Center St
Allen Dr
Dorsey Dr
Tydings Dr
Bay Town Rd
Spruill Rd
Womack Dr
Admiral Cochrane Dr
Harry S Truman Pkwy
Holly Ave
Pinewood St
Cedar Ave
Defense St
Loretta St
Eve Ln
Kater Ave
Somerville Rd
Old Solomons Island Rd
Exegesis St
Holeclaw St
Oaklawn
Link St
Center St
Neal St
Forest Dr
Harker Pl
Tower Pl
Holliday Ct
Hearne Rd
Riva Town Center Dr
Annapolis Harbour Center Dr

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FLOW_ROUTING   DYNWAVE
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REPORT_START_DATE   01/01/1989
REPORT_START_TIME   00:00:00
END_DATE   01/02/1989
END_TIME   00:00:00
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SWEEP_END   12/31
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WET_STEP   00:05:00
DRY_STEP   00:05:00
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VARIABLE_STEP   0.75
LENGTHENING_STEP   0
MIN_SURFAREA   0
NORMAL_FLOW_LIMITED BOTH
SKIP_STEADY_STATE   NO
FORCE_MAIN_EQUATION H-W
LINK_OFFSETS   DEPTH
MIN_SLOPE   0
MAX_TRIALS   8
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LAT_FLOW_TOL   5
MINIMUM_STEP   0.5
THREADS   4

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;;-------------- ----------
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DRY_ONLY   NO

[RAINGAGES]
;;   Rain   Time   Snow   Data
;;Name   Type   Intrvl Catch Source
;;-------------- --------- ------ ------ ----------
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10yr_24hr   VOLUME   0:05   1.0   TIMESERIES 10yr_24hr
1yr_24hr   VOLUME   0:05   1.0   TIMESERIES 1yr_24hr
2yr_24hr   VOLUME   0:05   1.0   TIMESERIES 2yr_24hr

[SUBCATCHMENTS]
;;   Total   Pcnt.   Pcnt.   Curb   Snow
;;Name   Raingage   Outlet   Area   Imperv   Width   Slope   Length   Pack
;;-------------- ---------------- ------------ -------- -------- ------- -------- -------- --------
;Modified Urban Stormwater BMP Review
S1   1yr_24hr   J7   4.3515   77.717   250   4.45   0
;Modified Urban Stormwater BMP Review
S11   1yr_24hr   J4   0.948   75.474   100   6.523   0
;Modified Urban Stormwater BMP Review
S12   1yr_24hr   OF1   6.7632   94.521   370   4.762   0
;Modified Urban Stormwater BMP Review
S14   1yr_24hr   J1   16.5114 65.022   700   6.424   0
;Modified KCI Drainage Area
S15   1yr_24hr   C-4   26.0041 85.496   120   5.233   0
;Modified KCI Drainage Area
S16   1yr_24hr   C-5   7.6515   62.032   560   10.863   0
;Modified KCI Drainage Area
S17   1yr_24hr   C-6   1.8694   43.848   250   17.354   0
;Modified Urban Stormwater BMP Review
S2   1yr_24hr   C-3   4.7466   46.975   250   10.435   0
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S23   1yr_24hr   OF5   3.2955   27.963   210   13.355   0
;Modified KCI Drainage Area
S24_1   1yr_24hr   J9   30.3058 86.25   660   5.4   0
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S24_2   1yr_24hr   OF1   5.5911   89.596   190   5.4   0
;Modified KCI Drainage Area
S25   1yr_24hr   J7   16.1406 69.63   470   7.912   0
;Modified KCI Drainage Area
S26   1yr_24hr   J4   26.0991 74.973   490   6.245   0
;Modified KCI Drainage Area
S27   1yr_24hr   J9   13.3416 85.032   530   5.731   0
;Modified KCI Drainage Area
S28   1yr_24hr   OF1   4.6769   98.206   170   3.378   0
;Modified KCI Drainage Area
S29   1yr_24hr   OF1   3.0003   84.624   190   5.82   0
;Modified Urban Stormwater BMP Review
S3   1yr_24hr   C-1   10.7295 82.724   250   7.108   0
;Modified KCI Drainage Area
S30_1   1yr_24hr   OF1   4.3801   0.62   240   26.16   0
;Modified KCI Drainage Area

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S30_2            1yr_24hr         OF4              2.1699   0.997    150      26.16    0
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S31_1            1yr_24hr         OF3              10.9772  5.086    260      18.698   0
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S31_2            1yr_24hr         OF4              4.2986   1.135    250      18.698   0
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S32              1yr_24hr         J1               1.3294   72.484   490      5.268    0
;Modified KCI Drainage Area
S33              1yr_24hr         J1               6.182    0.014    200      12.915   0
;Modified KCI Drainage Area
S34              1yr_24hr         J4               12.2525  72.325   540      9.501    0
;Modified KCI Drainage Area
S35              1yr_24hr         OF1              8.7548   70.645   320      7.796    0
;Modified KCI Drainage Area
S36              1yr_24hr         J6               14.2682  67.63    440      5.444    0
;Modified KCI Drainage Area
S37              1yr_24hr         OF3              4.7395   44.47    200      11.627   0
;Modified Urban Stormwater BMP Review
S4               1yr_24hr         C-1              5.793    84.213   350      5.301    0
;Modified Urban Stormwater BMP Review
S5               1yr_24hr         C-1              5.6003   82.905   330      4.545    0
;Modified Urban Stormwater BMP Review
S6               1yr_24hr         C-1              3.0637   95.158   270      4.332    0
;Modified Urban Stormwater BMP Review
S7               1yr_24hr         J8               1.5525   51.816   180      6.898    0
;Modified Urban Stormwater BMP Review
S8               1yr_24hr         J9               22.6868  84.75    650      3.845    0

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S11              0.01       0.1        1          1          0          OUTLET
S12              0.01       0.1        1          1          0          OUTLET
S14              0.01       0.1        1          1          0          OUTLET
S15              0.01       0.1        0.05       0.05       25         OUTLET
S16              0.01       0.1        0.05       0.05       25         OUTLET
S17              0.01       0.1        0.05       0.05       25         OUTLET
S2               0.01       0.1        0.05       0.05       25         OUTLET
S23              0.01       0.1        0.05       0.05       25         OUTLET
S24_1            0.01       0.1        0.05       0.05       25         OUTLET
S24_2            0.01       0.1        0.05       0.05       25         OUTLET
S25              0.01       0.1        0.05       0.05       25         OUTLET
S26              0.01       0.1        0.05       0.05       25         OUTLET
S27              0.01       0.1        0.05       0.05       25         OUTLET
S28              0.01       0.1        0.05       0.05       25         OUTLET
S29              0.01       0.1        0.05       0.05       25         OUTLET
S3               0.01       0.1        0.05       0.05       25         OUTLET
S30_1            0.01       0.1        0.05       0.05       25         OUTLET
S30_2            0.01       0.1        0.05       0.05       25         OUTLET
S31_1            0.01       0.1        0.05       0.05       25         OUTLET
S31_2            0.01       0.1        0.05       0.05       25         OUTLET
S32              0.01       0.1        0.05       0.05       25         OUTLET
S33              0.01       0.1        0.05       0.05       25         OUTLET
S34              0.01       0.1        0.05       0.05       25         OUTLET
S35              0.01       0.1        0.05       0.05       25         OUTLET
S36              0.01       0.1        0.05       0.05       25         OUTLET
S37              0.01       0.1        0.05       0.05       25         OUTLET
S4               0.01       0.1        1          1          0          OUTLET
S5               0.01       0.1        1          1          0          OUTLET
S6               0.01       0.1        1          1          0          OUTLET
S7               0.01       0.1        1          1          0          OUTLET
S8               0.01       0.1        1          1          0          OUTLET

[INFILTRATION]
;;Subcatchment   MaxRate    MinRate    Decay      DryTime    MaxInfil
;;-------------- ---------- ---------- ---------- ---------- ----------
S1               1.5        0.112      5.257      3.044      0
S11              0.752      0.05       6.012      2.065      0
S12              0.752      0.05       6.012      2.065      0
S14              1.532      0.115      5.225      3.086      0
S15              0.839      0.056      5.924      2.085      0
S16              1.684      0.112      5.069      2.275      0
S17              2.11       0.141      4.637      2.371      0
S2               0.795      0.054      5.969      2.121      0
S23              1.35       0.09       5.407      2.2        0
S24_1            0.918      0.064      5.845      2.282      0
S24_2            2.035      0.137      4.714      2.414      0
S25              1.416      0.104      5.342      2.867      0
S26              0.911      0.061      5.852      2.101      0
S27              1.038      0.074      5.724      2.439      0
S28              0.755      0.05       6.009      2.069      0
S29              1.535      0.115      5.222      3.089      0
S3               0.76       0.051      6.004      2.075      0
S30_1            3.549      0.283      3.19       5.685      0
S30_2            2.121      0.161      4.63       3.642      0
S31_1            2.205      0.167      4.545      3.671      0
S31_2            1.962      0.151      4.791      3.649      0
S32              3.304      0.263      3.437      5.406      0
S33              3.426      0.268      3.313      5.219      0
S34              1.526      0.103      5.229      2.318      0
S35              1.712      0.123      5.042      2.834      0
S36              1.112      0.08       5.649      2.536      0
S37              1.646      0.123      5.11       3.164      0
S4               0.752      0.05       6.012      2.065      0
```

```
S5               0.752      0.05       6.012      2.065      0
S6               0.752      0.05       6.012      2.065      0
S7               0.752      0.05       6.012      2.065      0
S8               0.753      0.05       6.011      2.066      0

[JUNCTIONS]
;;               Invert     Max.       Init.      Surcharge  Ponded
;;Name           Elev.      Depth      Depth      Depth      Area
;;-------------- ---------- ---------- ---------- ---------- ----------
J1               55.767     0          0          0          0
;lowered due to low bottom elevation of us pond
J2               60         0          0          0          0
J3               77         0          0          0          0
J4               50.73      0          0          0          0
J5               31.896     0          0          0          0
;Lowered invert elev. 10 ft from DEM under road
J6               54.29      0          0          0          0
J7               70.046     0          0          0          0
J8               73.167     0          0          0          0
;lowered invert elevation 1 ft from DEM to make lower than road
J9               44.596     0          0          0          0

[OUTFALLS]
;;               Invert     Outfall      Stage/Table      Tide
;;Name           Elev.      Type         Time Series      Gate Route To
;;-------------- ---------- ------------ ---------------- ---- ----------------
OF1              32.8       FREE                          NO
OF2              27.805     FREE                          NO
OF3              27.805     FREE                          NO
OF4              22.554     FREE                          NO
OF5              27.139     FREE                          NO
OF6              33.932     FREE                          NO

[STORAGE]
;;               Invert   Max.     Init.    Storage    Curve                      Ponded   Evap.
;;Name           Elev.    Depth    Depth    Curve      Params                     Area     Frac.    Infiltration parameters
;;-------------- -------- -------- -------- ---------- -------- -------- -------- -------- -------- ------------------------
;PWED-Extended Detention Structure, Wet
C-1              28.7     11.3     0        TABULAR    CC_1                       0        0
;XDPD-Detention Structure (Dry Pond) (plain old pond)
C-3              41       7        0        TABULAR    CC_4                       0        0
C-4              25.9     8.1      0        TABULAR    CC_5                       0        0
C-5              77       5        0        TABULAR    CC_7                       0        0
C-6              61       13       0        TABULAR    CC_8                       0        0

[CONDUITS]
;;               Inlet            Outlet                      Manning    Inlet      Outlet     Init.      Max.
;;Name           Node             Node             Length     N          Offset     Offset     Flow       Flow
;;-------------- ---------------- ---------------- ---------- ---------- ---------- ---------- ---------- ----------
C1               J3               J4               1576.94    0.01       0          0          0          0
C2               J2               J4               339.06     0.01       0          0          0          0
C3               J4               J5               896.83     0.01       0          0          0          0
C4               J5               OF3              734.77     0.01       0          0          0          0
C5               J6               C-1              1505.33    0.01       0          0          0          0
C6               J1               J5               954.89     0.01       0          0          0          0
C7               J7               J6               470.63     0.01       0          0          0          0
C8               J8               J9               1115.39    0.01       0          0          0          0
C9               J9               OF6              157.6      0.01       0          0          0          0

[ORIFICES]
;;               Inlet            Outlet           Orifice      Crest      Disch.     Flap Open/Close
;;Name           Node             Node             Type         Height     Coeff.     Gate Time
;;-------------- ---------------- ---------------- ------------ ---------- ---------- ---- ----------
;culvert
OR1              C-3              J5               SIDE         3.58       0.65       NO   0

[WEIRS]
;;               Inlet            Outlet           Weir         Crest      Disch.     Flap End      End
;;Name           Node             Node             Type         Height     Coeff.     Gate Con.     Coeff.     Surcharge
RoadWidth  RoadSurf
;;-------------- ---------------- ---------------- ------------ ---------- ---------- ---- -------- ---------- ---------- ------
---- ----------
;emergency spillway
W1               C-3              J5               TRAPEZOIDAL  5          3.33       NO   0        0          YES
W2               C-3              J5               TRANSVERSE   7          3.33       NO   0        0          YES

[OUTLETS]
;;               Inlet            Outlet           Outflow    Outlet           Qcoeff/                    Flap
;;Name           Node             Node             Height     Type             QTable           Qexpon    Gate
;;-------------- ---------------- ---------------- ---------- ---------------- ---------------- ---------- ----
OL10             C-1              OF2              0          TABULAR/DEPTH    CCO_1                       NO
OL7              C-6              J2               0          TABULAR/DEPTH    CCO_8                       NO
OL8              C-5              J3               0          TABULAR/DEPTH    CCO_7                       NO
OL9              C-4              OF4              0          TABULAR/DEPTH    CCO_5                       NO

[XSECTIONS]
;;Link           Shape        Geom1            Geom2      Geom3      Geom4      Barrels
;;-------------- ------------ ---------------- ---------- ---------- ---------- ----------
C1               CIRCULAR     1.25             0          0          0          1
C2               CIRCULAR     1                0          0          0          1
C3               TRAPEZOIDAL  20               3          3          3          1
C4               TRAPEZOIDAL  20               3          3          3          1
C5               CIRCULAR     4.5              0          0          0          1
C6               CIRCULAR     3.5              0          0          0          1
C7               CIRCULAR     3.5              0          0          0          1
```

```
C8               CIRCULAR     1.25             0          0          0          1
C9               CIRCULAR     4.5              0          0          0          1
OR1              CIRCULAR     1.25             0          0          0
W1               TRAPEZOIDAL  2                8          2          2
W2               RECT_OPEN    1                100        0          0

[LOSSES]
;;Link           Inlet      Outlet     Average    Flap Gate  SeepageRate
;;-------------- ---------- ---------- ---------- ---------- ----------

[CURVES]
;;Name           Type       X-Value    Y-Value
;;-------------- ---------- ---------- ----------
CCO_1            Rating     0.21       2.76879E-63
CCO_1                       0.851028744 1
CCO_1                       1.03       1.093183965
CCO_1                       1.235324122 3
CCO_1                       1.856798439 4
CCO_1                       2.618122561 5
CCO_1                       7.099696384 10
CCO_1                       7.260919529 15
CCO_1                       7.377204582 20.001
CCO_1                       7.477079002 25
CCO_1                       7.567543881 30
CCO_1                       7.651750486 35
CCO_1                       7.731577682 40
CCO_1                       7.80537322 45
CCO_1                       7.876711998 50
CCO_1                       8.94625    75
CCO_1                       9.495      100
CCO_1                       9.56125    125
CCO_1                       9.6175     150
CCO_1                       9.72       200
CCO_1                       11.3       350

CCO_5            Rating     0.041464844 0.000273004
CCO_5                       1.158774414 0.999989263
CCO_5                       2.15712265 1.999876618
CCO_5                       2.207419434 3.001682535
CCO_5                       2.247702637 4.000324832
CCO_5                       2.289499512 4.995344068
CCO_5                       2.330328064 6.000024624
CCO_5                       2.372392578 6.977235885
CCO_5                       2.76       8
CCO_5                       3.475      9
CCO_5                       4.19       10
CCO_5                       4.27       20
CCO_5                       4.32       30
CCO_5                       4.395      45
CCO_5                       4.42       50
CCO_5                       4.470005   60.001
CCO_5                       4.520005   70.001
CCO_5                       4.57       80
CCO_5                       4.62       90
CCO_5                       4.67       100

CCO_7            Rating     0.83       0
CCO_7                       1.670976155 1
CCO_7                       2.08       0.956687194
CCO_7                       2.24652116 3
CCO_7                       2.833259841 4
CCO_7                       3.477281001 5
CCO_7                       4.178584641 6
CCO_7                       4.576679738 7
CCO_7                       4.660210673 8
CCO_7                       4.733672588 9
CCO_7                       6.62375    15
CCO_7                       7.032857143 20
CCO_7                       7.061428571 25
CCO_7                       7.09       30
CCO_7                       7.123333333 40
CCO_7                       7.15625    50
CCO_7                       7.1875     60
CCO_7                       7.215      70
CCO_7                       7.24       80

CCO_8            Rating     3.002929688 0.000491579
CCO_8                       3.470581055 1.00072178
CCO_8                       3.745605469 1.995838155
CCO_8                       4.128662109 2.998421671
CCO_8                       4.618835449 4.00006616
CCO_8                       5.247802734 4.999542593
CCO_8                       6.016845703 5.999462751
CCO_8                       6.542816162 6.999532618
CCO_8                       6.595687866 7.999790647
CCO_8                       6.636932373 9.002232529
CCO_8                       6.672546387 9.995279702
CCO_8                       6.704956055 10.98981355
CCO_8                       6.735622559 12.00377529
CCO_8                       6.763813477 12.99420333
CCO_8                       6.791088867 14.00264031
CCO_8                       6.818181152 15.00717449
CCO_8                       6.960051618 19.97377548
CCO_8                       7.091256278 24.99642553
CCO_8                       11.26111111 40
```

```
CCO_8                      15.25375   50

CC_1             Storage   0          0
CC_1                       3.3        19115
CC_1                       7.3        26817
CC_1                       9.3        32520
CC_1                       11.3       39480

CC_4             Storage   0          0
CC_4                       1          6480
CC_4                       5          10460
CC_4                       7          12503

CC_5             Storage   0          0
CC_5                       0.1        22674
CC_5                       4.1        30230
CC_5                       6.1        33260
CC_5                       8.1        42240

CC_7             Storage   0          0
CC_7                       1          16050
CC_7                       3          24717
CC_7                       5          77290

CC_8             Storage   0          0
CC_8                       5          5025
CC_8                       9          9560
CC_8                       11         12368
CC_8                       13         16360

[TIMESERIES]
;;Name           Date       Time       Value
;;-------------- ---------- ---------- ----------
100yr_24hr       1/1/1989   0:00       0.0000
100yr_24hr       1/1/1989   0:05       0.0108
100yr_24hr       1/1/1989   0:10       0.0108
100yr_24hr       1/1/1989   0:15       0.0108
100yr_24hr       1/1/1989   0:20       0.0108
100yr_24hr       1/1/1989   0:25       0.0108
100yr_24hr       1/1/1989   0:30       0.0108
100yr_24hr       1/1/1989   0:35       0.0108
100yr_24hr       1/1/1989   0:40       0.0108
100yr_24hr       1/1/1989   0:45       0.0108
100yr_24hr       1/1/1989   0:50       0.0108
100yr_24hr       1/1/1989   0:55       0.0108
100yr_24hr       1/1/1989   1:00       0.0108
100yr_24hr       1/1/1989   1:05       0.0108
100yr_24hr       1/1/1989   1:10       0.0108
100yr_24hr       1/1/1989   1:15       0.0108
100yr_24hr       1/1/1989   1:20       0.0108
100yr_24hr       1/1/1989   1:25       0.0108
100yr_24hr       1/1/1989   1:30       0.0108
100yr_24hr       1/1/1989   1:35       0.0108
100yr_24hr       1/1/1989   1:40       0.0108
100yr_24hr       1/1/1989   1:45       0.0108
100yr_24hr       1/1/1989   1:50       0.0108
100yr_24hr       1/1/1989   1:55       0.0108
100yr_24hr       1/1/1989   2:00       0.0108
100yr_24hr       1/1/1989   2:05       0.0108
100yr_24hr       1/1/1989   2:10       0.0108
100yr_24hr       1/1/1989   2:15       0.0108
100yr_24hr       1/1/1989   2:20       0.0108
100yr_24hr       1/1/1989   2:25       0.0108
100yr_24hr       1/1/1989   2:30       0.0108
100yr_24hr       1/1/1989   2:35       0.0108
100yr_24hr       1/1/1989   2:40       0.0108
100yr_24hr       1/1/1989   2:45       0.0108
100yr_24hr       1/1/1989   2:50       0.0108
100yr_24hr       1/1/1989   2:55       0.0108
100yr_24hr       1/1/1989   3:00       0.0108
100yr_24hr       1/1/1989   3:05       0.0108
100yr_24hr       1/1/1989   3:10       0.0108
100yr_24hr       1/1/1989   3:15       0.0108
100yr_24hr       1/1/1989   3:20       0.0108
100yr_24hr       1/1/1989   3:25       0.0108
100yr_24hr       1/1/1989   3:30       0.0108
100yr_24hr       1/1/1989   3:35       0.0108
100yr_24hr       1/1/1989   3:40       0.0108
100yr_24hr       1/1/1989   3:45       0.0108
100yr_24hr       1/1/1989   3:50       0.0108
100yr_24hr       1/1/1989   3:55       0.0108
100yr_24hr       1/1/1989   4:00       0.0108
100yr_24hr       1/1/1989   4:05       0.0108
100yr_24hr       1/1/1989   4:10       0.0108
100yr_24hr       1/1/1989   4:15       0.0108
100yr_24hr       1/1/1989   4:20       0.0108
100yr_24hr       1/1/1989   4:25       0.0108
100yr_24hr       1/1/1989   4:30       0.0108
100yr_24hr       1/1/1989   4:35       0.0108
100yr_24hr       1/1/1989   4:40       0.0108
100yr_24hr       1/1/1989   4:45       0.0108
100yr_24hr       1/1/1989   4:50       0.0108
100yr_24hr       1/1/1989   4:55       0.0108
100yr_24hr       1/1/1989   5:00       0.0108
100yr_24hr       1/1/1989   5:05       0.0108
```

100yr_24hr	1/1/1989	5:10	0.0108
100yr_24hr	1/1/1989	5:15	0.0108
100yr_24hr	1/1/1989	5:20	0.0108
100yr_24hr	1/1/1989	5:25	0.0108
100yr_24hr	1/1/1989	5:30	0.0108
100yr_24hr	1/1/1989	5:35	0.0108
100yr_24hr	1/1/1989	5:40	0.0108
100yr_24hr	1/1/1989	5:45	0.0108
100yr_24hr	1/1/1989	5:50	0.0108
100yr_24hr	1/1/1989	5:55	0.0108
100yr_24hr	1/1/1989	6:00	0.0108
100yr_24hr	1/1/1989	6:05	0.0208
100yr_24hr	1/1/1989	6:10	0.0208
100yr_24hr	1/1/1989	6:15	0.0208
100yr_24hr	1/1/1989	6:20	0.0208
100yr_24hr	1/1/1989	6:25	0.0208
100yr_24hr	1/1/1989	6:30	0.0208
100yr_24hr	1/1/1989	6:35	0.0208
100yr_24hr	1/1/1989	6:40	0.0208
100yr_24hr	1/1/1989	6:45	0.0208
100yr_24hr	1/1/1989	6:50	0.0208
100yr_24hr	1/1/1989	6:55	0.0208
100yr_24hr	1/1/1989	7:00	0.0208
100yr_24hr	1/1/1989	7:05	0.0208
100yr_24hr	1/1/1989	7:10	0.0208
100yr_24hr	1/1/1989	7:15	0.0208
100yr_24hr	1/1/1989	7:20	0.0208
100yr_24hr	1/1/1989	7:25	0.0208
100yr_24hr	1/1/1989	7:30	0.0208
100yr_24hr	1/1/1989	7:35	0.0208
100yr_24hr	1/1/1989	7:40	0.0208
100yr_24hr	1/1/1989	7:45	0.0208
100yr_24hr	1/1/1989	7:50	0.0208
100yr_24hr	1/1/1989	7:55	0.0208
100yr_24hr	1/1/1989	8:00	0.0208
100yr_24hr	1/1/1989	8:05	0.0208
100yr_24hr	1/1/1989	8:10	0.0208
100yr_24hr	1/1/1989	8:15	0.0208
100yr_24hr	1/1/1989	8:20	0.0208
100yr_24hr	1/1/1989	8:25	0.0208
100yr_24hr	1/1/1989	8:30	0.0208
100yr_24hr	1/1/1989	8:35	0.0208
100yr_24hr	1/1/1989	8:40	0.0208
100yr_24hr	1/1/1989	8:45	0.0208
100yr_24hr	1/1/1989	8:50	0.0208
100yr_24hr	1/1/1989	8:55	0.0208
100yr_24hr	1/1/1989	9:00	0.0208
100yr_24hr	1/1/1989	9:05	0.0308
100yr_24hr	1/1/1989	9:10	0.0308
100yr_24hr	1/1/1989	9:15	0.0308
100yr_24hr	1/1/1989	9:20	0.0308
100yr_24hr	1/1/1989	9:25	0.0308
100yr_24hr	1/1/1989	9:30	0.0308
100yr_24hr	1/1/1989	9:35	0.0308
100yr_24hr	1/1/1989	9:40	0.0308
100yr_24hr	1/1/1989	9:45	0.0308
100yr_24hr	1/1/1989	9:50	0.0308
100yr_24hr	1/1/1989	9:55	0.0308
100yr_24hr	1/1/1989	10:00	0.0308
100yr_24hr	1/1/1989	10:05	0.0308
100yr_24hr	1/1/1989	10:10	0.0308
100yr_24hr	1/1/1989	10:15	0.0308
100yr_24hr	1/1/1989	10:20	0.0308
100yr_24hr	1/1/1989	10:25	0.0308
100yr_24hr	1/1/1989	10:30	0.0308
100yr_24hr	1/1/1989	10:35	0.0325
100yr_24hr	1/1/1989	10:40	0.0325
100yr_24hr	1/1/1989	10:45	0.0325
100yr_24hr	1/1/1989	10:50	0.0325
100yr_24hr	1/1/1989	10:55	0.0325
100yr_24hr	1/1/1989	11:00	0.0325
100yr_24hr	1/1/1989	11:05	0.0567
100yr_24hr	1/1/1989	11:10	0.0567
100yr_24hr	1/1/1989	11:15	0.0567
100yr_24hr	1/1/1989	11:20	0.0567
100yr_24hr	1/1/1989	11:25	0.0567
100yr_24hr	1/1/1989	11:30	0.0567
100yr_24hr	1/1/1989	11:35	0.1442
100yr_24hr	1/1/1989	11:40	0.1442
100yr_24hr	1/1/1989	11:45	0.1442
100yr_24hr	1/1/1989	11:50	0.2658
100yr_24hr	1/1/1989	11:55	0.3125
100yr_24hr	1/1/1989	12:00	0.7458
100yr_24hr	1/1/1989	12:05	0.4392
100yr_24hr	1/1/1989	12:10	0.2658
100yr_24hr	1/1/1989	12:15	0.2658
100yr_24hr	1/1/1989	12:20	0.1442
100yr_24hr	1/1/1989	12:25	0.1442
100yr_24hr	1/1/1989	12:30	0.1442
100yr_24hr	1/1/1989	12:35	0.0567
100yr_24hr	1/1/1989	12:40	0.0567
100yr_24hr	1/1/1989	12:45	0.0567
100yr_24hr	1/1/1989	12:50	0.0567
100yr_24hr	1/1/1989	12:55	0.0567
100yr_24hr	1/1/1989	13:00	0.0567

100yr_24hr	1/1/1989	13:05	0.0325
100yr_24hr	1/1/1989	13:10	0.0325
100yr_24hr	1/1/1989	13:15	0.0325
100yr_24hr	1/1/1989	13:20	0.0325
100yr_24hr	1/1/1989	13:25	0.0325
100yr_24hr	1/1/1989	13:30	0.0325
100yr_24hr	1/1/1989	13:35	0.0308
100yr_24hr	1/1/1989	13:40	0.0308
100yr_24hr	1/1/1989	13:45	0.0308
100yr_24hr	1/1/1989	13:50	0.0308
100yr_24hr	1/1/1989	13:55	0.0308
100yr_24hr	1/1/1989	14:00	0.0308
100yr_24hr	1/1/1989	14:05	0.0308
100yr_24hr	1/1/1989	14:10	0.0308
100yr_24hr	1/1/1989	14:15	0.0308
100yr_24hr	1/1/1989	14:20	0.0308
100yr_24hr	1/1/1989	14:25	0.0308
100yr_24hr	1/1/1989	14:30	0.0308
100yr_24hr	1/1/1989	14:35	0.0308
100yr_24hr	1/1/1989	14:40	0.0308
100yr_24hr	1/1/1989	14:45	0.0308
100yr_24hr	1/1/1989	14:50	0.0308
100yr_24hr	1/1/1989	14:55	0.0308
100yr_24hr	1/1/1989	15:00	0.0308
100yr_24hr	1/1/1989	15:05	0.0208
100yr_24hr	1/1/1989	15:10	0.0208
100yr_24hr	1/1/1989	15:15	0.0208
100yr_24hr	1/1/1989	15:20	0.0208
100yr_24hr	1/1/1989	15:25	0.0208
100yr_24hr	1/1/1989	15:30	0.0208
100yr_24hr	1/1/1989	15:35	0.0208
100yr_24hr	1/1/1989	15:40	0.0208
100yr_24hr	1/1/1989	15:45	0.0208
100yr_24hr	1/1/1989	15:50	0.0208
100yr_24hr	1/1/1989	15:55	0.0208
100yr_24hr	1/1/1989	16:00	0.0208
100yr_24hr	1/1/1989	16:05	0.0208
100yr_24hr	1/1/1989	16:10	0.0208
100yr_24hr	1/1/1989	16:15	0.0208
100yr_24hr	1/1/1989	16:20	0.0208
100yr_24hr	1/1/1989	16:25	0.0208
100yr_24hr	1/1/1989	16:30	0.0208
100yr_24hr	1/1/1989	16:35	0.0208
100yr_24hr	1/1/1989	16:40	0.0208
100yr_24hr	1/1/1989	16:45	0.0208
100yr_24hr	1/1/1989	16:50	0.0208
100yr_24hr	1/1/1989	16:55	0.0208
100yr_24hr	1/1/1989	17:00	0.0208
100yr_24hr	1/1/1989	17:05	0.0208
100yr_24hr	1/1/1989	17:10	0.0208
100yr_24hr	1/1/1989	17:15	0.0208
100yr_24hr	1/1/1989	17:20	0.0208
100yr_24hr	1/1/1989	17:25	0.0208
100yr_24hr	1/1/1989	17:30	0.0208
100yr_24hr	1/1/1989	17:35	0.0208
100yr_24hr	1/1/1989	17:40	0.0208
100yr_24hr	1/1/1989	17:45	0.0208
100yr_24hr	1/1/1989	17:50	0.0208
100yr_24hr	1/1/1989	17:55	0.0208
100yr_24hr	1/1/1989	18:00	0.0208
100yr_24hr	1/1/1989	18:05	0.0108
100yr_24hr	1/1/1989	18:10	0.0108
100yr_24hr	1/1/1989	18:15	0.0108
100yr_24hr	1/1/1989	18:20	0.0108
100yr_24hr	1/1/1989	18:25	0.0108
100yr_24hr	1/1/1989	18:30	0.0108
100yr_24hr	1/1/1989	18:35	0.0108
100yr_24hr	1/1/1989	18:40	0.0108
100yr_24hr	1/1/1989	18:45	0.0108
100yr_24hr	1/1/1989	18:50	0.0108
100yr_24hr	1/1/1989	18:55	0.0108
100yr_24hr	1/1/1989	19:00	0.0108
100yr_24hr	1/1/1989	19:05	0.0108
100yr_24hr	1/1/1989	19:10	0.0108
100yr_24hr	1/1/1989	19:15	0.0108
100yr_24hr	1/1/1989	19:20	0.0108
100yr_24hr	1/1/1989	19:25	0.0108
100yr_24hr	1/1/1989	19:30	0.0108
100yr_24hr	1/1/1989	19:35	0.0108
100yr_24hr	1/1/1989	19:40	0.0108
100yr_24hr	1/1/1989	19:45	0.0108
100yr_24hr	1/1/1989	19:50	0.0108
100yr_24hr	1/1/1989	19:55	0.0108
100yr_24hr	1/1/1989	20:00	0.0108
100yr_24hr	1/1/1989	20:05	0.0108
100yr_24hr	1/1/1989	20:10	0.0108
100yr_24hr	1/1/1989	20:15	0.0108
100yr_24hr	1/1/1989	20:20	0.0108
100yr_24hr	1/1/1989	20:25	0.0108
100yr_24hr	1/1/1989	20:30	0.0108
100yr_24hr	1/1/1989	20:35	0.0108
100yr_24hr	1/1/1989	20:40	0.0108
100yr_24hr	1/1/1989	20:45	0.0108
100yr_24hr	1/1/1989	20:50	0.0108
100yr_24hr	1/1/1989	20:55	0.0108

100yr_24hr	1/1/1989	21:00	0.0108
100yr_24hr	1/1/1989	21:05	0.0108
100yr_24hr	1/1/1989	21:10	0.0108
100yr_24hr	1/1/1989	21:15	0.0108
100yr_24hr	1/1/1989	21:20	0.0108
100yr_24hr	1/1/1989	21:25	0.0108
100yr_24hr	1/1/1989	21:30	0.0108
100yr_24hr	1/1/1989	21:35	0.0108
100yr_24hr	1/1/1989	21:40	0.0108
100yr_24hr	1/1/1989	21:45	0.0108
100yr_24hr	1/1/1989	21:50	0.0108
100yr_24hr	1/1/1989	21:55	0.0108
100yr_24hr	1/1/1989	22:00	0.0108
100yr_24hr	1/1/1989	22:05	0.0108
100yr_24hr	1/1/1989	22:10	0.0108
100yr_24hr	1/1/1989	22:15	0.0108
100yr_24hr	1/1/1989	22:20	0.0108
100yr_24hr	1/1/1989	22:25	0.0108
100yr_24hr	1/1/1989	22:30	0.0108
100yr_24hr	1/1/1989	22:35	0.0108
100yr_24hr	1/1/1989	22:40	0.0108
100yr_24hr	1/1/1989	22:45	0.0108
100yr_24hr	1/1/1989	22:50	0.0108
100yr_24hr	1/1/1989	22:55	0.0108
100yr_24hr	1/1/1989	23:00	0.0108
100yr_24hr	1/1/1989	23:05	0.0108
100yr_24hr	1/1/1989	23:10	0.0108
100yr_24hr	1/1/1989	23:15	0.0108
100yr_24hr	1/1/1989	23:20	0.0108
100yr_24hr	1/1/1989	23:25	0.0108
100yr_24hr	1/1/1989	23:30	0.0108
100yr_24hr	1/1/1989	23:35	0.0108
100yr_24hr	1/1/1989	23:40	0.0108
100yr_24hr	1/1/1989	23:45	0.0108
100yr_24hr	1/1/1989	23:50	0.0108
100yr_24hr	1/1/1989	23:55	0.0108
10yr_24hr	1/1/1989	0:00	0.0000
10yr_24hr	1/1/1989	0:05	0.0050
10yr_24hr	1/1/1989	0:10	0.0050
10yr_24hr	1/1/1989	0:15	0.0050
10yr_24hr	1/1/1989	0:20	0.0050
10yr_24hr	1/1/1989	0:25	0.0050
10yr_24hr	1/1/1989	0:30	0.0050
10yr_24hr	1/1/1989	0:35	0.0050
10yr_24hr	1/1/1989	0:40	0.0050
10yr_24hr	1/1/1989	0:45	0.0050
10yr_24hr	1/1/1989	0:50	0.0050
10yr_24hr	1/1/1989	0:55	0.0050
10yr_24hr	1/1/1989	1:00	0.0050
10yr_24hr	1/1/1989	1:05	0.0050
10yr_24hr	1/1/1989	1:10	0.0050
10yr_24hr	1/1/1989	1:15	0.0050
10yr_24hr	1/1/1989	1:20	0.0050
10yr_24hr	1/1/1989	1:25	0.0050
10yr_24hr	1/1/1989	1:30	0.0050
10yr_24hr	1/1/1989	1:35	0.0050
10yr_24hr	1/1/1989	1:40	0.0050
10yr_24hr	1/1/1989	1:45	0.0050
10yr_24hr	1/1/1989	1:50	0.0050
10yr_24hr	1/1/1989	1:55	0.0050
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10yr_24hr	1/1/1989	2:05	0.0050
10yr_24hr	1/1/1989	2:10	0.0050
10yr_24hr	1/1/1989	2:15	0.0050
10yr_24hr	1/1/1989	2:20	0.0050
10yr_24hr	1/1/1989	2:25	0.0050
10yr_24hr	1/1/1989	2:30	0.0050
10yr_24hr	1/1/1989	2:35	0.0050
10yr_24hr	1/1/1989	2:40	0.0050
10yr_24hr	1/1/1989	2:45	0.0050
10yr_24hr	1/1/1989	2:50	0.0050
10yr_24hr	1/1/1989	2:55	0.0050
10yr_24hr	1/1/1989	3:00	0.0050
10yr_24hr	1/1/1989	3:05	0.0050
10yr_24hr	1/1/1989	3:10	0.0050
10yr_24hr	1/1/1989	3:15	0.0050
10yr_24hr	1/1/1989	3:20	0.0050
10yr_24hr	1/1/1989	3:25	0.0050
10yr_24hr	1/1/1989	3:30	0.0050
10yr_24hr	1/1/1989	3:35	0.0050
10yr_24hr	1/1/1989	3:40	0.0050
10yr_24hr	1/1/1989	3:45	0.0050
10yr_24hr	1/1/1989	3:50	0.0050
10yr_24hr	1/1/1989	3:55	0.0050
10yr_24hr	1/1/1989	4:00	0.0050
10yr_24hr	1/1/1989	4:05	0.0050
10yr_24hr	1/1/1989	4:10	0.0050
10yr_24hr	1/1/1989	4:15	0.0050
10yr_24hr	1/1/1989	4:20	0.0050
10yr_24hr	1/1/1989	4:25	0.0050
10yr_24hr	1/1/1989	4:30	0.0050
10yr_24hr	1/1/1989	4:35	0.0050
10yr_24hr	1/1/1989	4:40	0.0050
10yr_24hr	1/1/1989	4:45	0.0050

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10yr_24hr	1/1/1989	4:55	0.0050
10yr_24hr	1/1/1989	5:00	0.0050
10yr_24hr	1/1/1989	5:05	0.0050
10yr_24hr	1/1/1989	5:10	0.0050
10yr_24hr	1/1/1989	5:15	0.0050
10yr_24hr	1/1/1989	5:20	0.0050
10yr_24hr	1/1/1989	5:25	0.0050
10yr_24hr	1/1/1989	5:30	0.0050
10yr_24hr	1/1/1989	5:35	0.0050
10yr_24hr	1/1/1989	5:40	0.0050
10yr_24hr	1/1/1989	5:45	0.0050
10yr_24hr	1/1/1989	5:50	0.0050
10yr_24hr	1/1/1989	5:55	0.0050
10yr_24hr	1/1/1989	6:00	0.0050
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10yr_24hr	1/1/1989	6:15	0.0100
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10yr_24hr	1/1/1989	6:25	0.0100
10yr_24hr	1/1/1989	6:30	0.0100
10yr_24hr	1/1/1989	6:35	0.0100
10yr_24hr	1/1/1989	6:40	0.0100
10yr_24hr	1/1/1989	6:45	0.0100
10yr_24hr	1/1/1989	6:50	0.0100
10yr_24hr	1/1/1989	6:55	0.0100
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10yr_24hr	1/1/1989	7:55	0.0100
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10yr_24hr	1/1/1989	8:15	0.0100
10yr_24hr	1/1/1989	8:20	0.0100
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10yr_24hr	1/1/1989	9:15	0.0175
10yr_24hr	1/1/1989	9:20	0.0175
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10yr_24hr	1/1/1989	9:30	0.0175
10yr_24hr	1/1/1989	9:35	0.0175
10yr_24hr	1/1/1989	9:40	0.0175
10yr_24hr	1/1/1989	9:45	0.0175
10yr_24hr	1/1/1989	9:50	0.0175
10yr_24hr	1/1/1989	9:55	0.0175
10yr_24hr	1/1/1989	10:00	0.0175
10yr_24hr	1/1/1989	10:05	0.0175
10yr_24hr	1/1/1989	10:10	0.0175
10yr_24hr	1/1/1989	10:15	0.0175
10yr_24hr	1/1/1989	10:20	0.0175
10yr_24hr	1/1/1989	10:25	0.0175
10yr_24hr	1/1/1989	10:30	0.0175
10yr_24hr	1/1/1989	10:35	0.0175
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10yr_24hr	1/1/1989	10:45	0.0175
10yr_24hr	1/1/1989	10:50	0.0175
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10yr_24hr	1/1/1989	11:35	0.0825
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10yr_24hr	1/1/1989	12:00	0.5617
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10yr_24hr	1/1/1989	12:10	0.1700
10yr_24hr	1/1/1989	12:15	0.1700
10yr_24hr	1/1/1989	12:20	0.0825
10yr_24hr	1/1/1989	12:25	0.0825
10yr_24hr	1/1/1989	12:30	0.0825
10yr_24hr	1/1/1989	12:35	0.0317
10yr_24hr	1/1/1989	12:40	0.0317

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10yr_24hr	1/1/1989	12:50	0.0317
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10yr_24hr	1/1/1989	13:00	0.0317
10yr_24hr	1/1/1989	13:05	0.0175
10yr_24hr	1/1/1989	13:10	0.0175
10yr_24hr	1/1/1989	13:15	0.0175
10yr_24hr	1/1/1989	13:20	0.0175
10yr_24hr	1/1/1989	13:25	0.0175
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10yr_24hr	1/1/1989	14:15	0.0175
10yr_24hr	1/1/1989	14:20	0.0175
10yr_24hr	1/1/1989	14:25	0.0175
10yr_24hr	1/1/1989	14:30	0.0175
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10yr_24hr	1/1/1989	14:40	0.0175
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10yr_24hr	1/1/1989	14:50	0.0175
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10yr_24hr	1/1/1989	15:55	0.0100
10yr_24hr	1/1/1989	16:00	0.0100
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10yr_24hr	1/1/1989	18:00	0.0100
10yr_24hr	1/1/1989	18:05	0.0050
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10yr_24hr	1/1/1989	19:00	0.0050
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10yr_24hr	1/1/1989	21:25	0.0050
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10yr_24hr	1/1/1989	21:45	0.0050
10yr_24hr	1/1/1989	21:50	0.0050
10yr_24hr	1/1/1989	21:55	0.0050
10yr_24hr	1/1/1989	22:00	0.0050
10yr_24hr	1/1/1989	22:05	0.0050
10yr_24hr	1/1/1989	22:10	0.0050
10yr_24hr	1/1/1989	22:15	0.0050
10yr_24hr	1/1/1989	22:20	0.0050
10yr_24hr	1/1/1989	22:25	0.0050
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10yr_24hr	1/1/1989	22:50	0.0050
10yr_24hr	1/1/1989	22:55	0.0050
10yr_24hr	1/1/1989	23:00	0.0050
10yr_24hr	1/1/1989	23:05	0.0050
10yr_24hr	1/1/1989	23:10	0.0050
10yr_24hr	1/1/1989	23:15	0.0050
10yr_24hr	1/1/1989	23:20	0.0050
10yr_24hr	1/1/1989	23:25	0.0050
10yr_24hr	1/1/1989	23:30	0.0050
10yr_24hr	1/1/1989	23:35	0.0050
10yr_24hr	1/1/1989	23:40	0.0050
10yr_24hr	1/1/1989	23:45	0.0050
10yr_24hr	1/1/1989	23:50	0.0050
10yr_24hr	1/1/1989	23:55	0.0050
1yr_24hr	1/1/1989	0:00	0.0000
1yr_24hr	1/1/1989	0:05	0.0025
1yr_24hr	1/1/1989	0:10	0.0025
1yr_24hr	1/1/1989	0:15	0.0025
1yr_24hr	1/1/1989	0:20	0.0025
1yr_24hr	1/1/1989	0:25	0.0025
1yr_24hr	1/1/1989	0:30	0.0025
1yr_24hr	1/1/1989	0:35	0.0025
1yr_24hr	1/1/1989	0:40	0.0025
1yr_24hr	1/1/1989	0:45	0.0025
1yr_24hr	1/1/1989	0:50	0.0025
1yr_24hr	1/1/1989	0:55	0.0025
1yr_24hr	1/1/1989	1:00	0.0025
1yr_24hr	1/1/1989	1:05	0.0025
1yr_24hr	1/1/1989	1:10	0.0025
1yr_24hr	1/1/1989	1:15	0.0025
1yr_24hr	1/1/1989	1:20	0.0025
1yr_24hr	1/1/1989	1:25	0.0025
1yr_24hr	1/1/1989	1:30	0.0025
1yr_24hr	1/1/1989	1:35	0.0025
1yr_24hr	1/1/1989	1:40	0.0025
1yr_24hr	1/1/1989	1:45	0.0025
1yr_24hr	1/1/1989	1:50	0.0025
1yr_24hr	1/1/1989	1:55	0.0025
1yr_24hr	1/1/1989	2:00	0.0025
1yr_24hr	1/1/1989	2:05	0.0025
1yr_24hr	1/1/1989	2:10	0.0025
1yr_24hr	1/1/1989	2:15	0.0025
1yr_24hr	1/1/1989	2:20	0.0025
1yr_24hr	1/1/1989	2:25	0.0025
1yr_24hr	1/1/1989	2:30	0.0025
1yr_24hr	1/1/1989	2:35	0.0025
1yr_24hr	1/1/1989	2:40	0.0025
1yr_24hr	1/1/1989	2:45	0.0025
1yr_24hr	1/1/1989	2:50	0.0025
1yr_24hr	1/1/1989	2:55	0.0025
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1yr_24hr	1/1/1989	3:05	0.0025
1yr_24hr	1/1/1989	3:10	0.0025
1yr_24hr	1/1/1989	3:15	0.0025
1yr_24hr	1/1/1989	3:20	0.0025
1yr_24hr	1/1/1989	3:25	0.0025
1yr_24hr	1/1/1989	3:30	0.0025
1yr_24hr	1/1/1989	3:35	0.0025
1yr_24hr	1/1/1989	3:40	0.0025
1yr_24hr	1/1/1989	3:45	0.0025
1yr_24hr	1/1/1989	3:50	0.0025
1yr_24hr	1/1/1989	3:55	0.0025
1yr_24hr	1/1/1989	4:00	0.0025
1yr_24hr	1/1/1989	4:05	0.0025
1yr_24hr	1/1/1989	4:10	0.0025
1yr_24hr	1/1/1989	4:15	0.0025
1yr_24hr	1/1/1989	4:20	0.0025
1yr_24hr	1/1/1989	4:25	0.0025

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1yr_24hr	1/1/1989	4:40	0.0025
1yr_24hr	1/1/1989	4:45	0.0025
1yr_24hr	1/1/1989	4:50	0.0025
1yr_24hr	1/1/1989	4:55	0.0025
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1yr_24hr	1/1/1989	5:05	0.0025
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1yr_24hr	1/1/1989	5:15	0.0025
1yr_24hr	1/1/1989	5:20	0.0025
1yr_24hr	1/1/1989	5:25	0.0025
1yr_24hr	1/1/1989	5:30	0.0025
1yr_24hr	1/1/1989	5:35	0.0025
1yr_24hr	1/1/1989	5:40	0.0025
1yr_24hr	1/1/1989	5:45	0.0025
1yr_24hr	1/1/1989	5:50	0.0025
1yr_24hr	1/1/1989	5:55	0.0025
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1yr_24hr	1/1/1989	6:05	0.0058
1yr_24hr	1/1/1989	6:10	0.0058
1yr_24hr	1/1/1989	6:15	0.0058
1yr_24hr	1/1/1989	6:20	0.0058
1yr_24hr	1/1/1989	6:25	0.0058
1yr_24hr	1/1/1989	6:30	0.0058
1yr_24hr	1/1/1989	6:35	0.0058
1yr_24hr	1/1/1989	6:40	0.0058
1yr_24hr	1/1/1989	6:45	0.0058
1yr_24hr	1/1/1989	6:50	0.0058
1yr_24hr	1/1/1989	6:55	0.0058
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1yr_24hr	1/1/1989	7:20	0.0058
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1yr_24hr	1/1/1989	7:40	0.0058
1yr_24hr	1/1/1989	7:45	0.0058
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1yr_24hr	1/1/1989	7:55	0.0058
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1yr_24hr	1/1/1989	8:05	0.0058
1yr_24hr	1/1/1989	8:10	0.0058
1yr_24hr	1/1/1989	8:15	0.0058
1yr_24hr	1/1/1989	8:20	0.0058
1yr_24hr	1/1/1989	8:25	0.0058
1yr_24hr	1/1/1989	8:30	0.0058
1yr_24hr	1/1/1989	8:35	0.0058
1yr_24hr	1/1/1989	8:40	0.0058
1yr_24hr	1/1/1989	8:45	0.0058
1yr_24hr	1/1/1989	8:50	0.0058
1yr_24hr	1/1/1989	8:55	0.0058
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1yr_24hr	1/1/1989	9:15	0.0067
1yr_24hr	1/1/1989	9:20	0.0067
1yr_24hr	1/1/1989	9:25	0.0067
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1yr_24hr	1/1/1989	9:45	0.0100
1yr_24hr	1/1/1989	9:50	0.0100
1yr_24hr	1/1/1989	9:55	0.0100
1yr_24hr	1/1/1989	10:00	0.0100
1yr_24hr	1/1/1989	10:05	0.0100
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1yr_24hr	1/1/1989	10:20	0.0100
1yr_24hr	1/1/1989	10:25	0.0100
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1yr_24hr	1/1/1989	11:40	0.0392
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1yr_24hr	1/1/1989	11:55	0.1392
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1yr_24hr	1/1/1989	12:05	0.2117
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1yr_24hr	1/1/1989	12:20	0.0392

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1yr_24hr	1/1/1989	12:30	0.0392
1yr_24hr	1/1/1989	12:35	0.0183
1yr_24hr	1/1/1989	12:40	0.0183
1yr_24hr	1/1/1989	12:45	0.0183
1yr_24hr	1/1/1989	12:50	0.0183
1yr_24hr	1/1/1989	12:55	0.0183
1yr_24hr	1/1/1989	13:00	0.0183
1yr_24hr	1/1/1989	13:05	0.0100
1yr_24hr	1/1/1989	13:10	0.0100
1yr_24hr	1/1/1989	13:15	0.0100
1yr_24hr	1/1/1989	13:20	0.0100
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1yr_24hr	1/1/1989	13:35	0.0100
1yr_24hr	1/1/1989	13:40	0.0100
1yr_24hr	1/1/1989	13:45	0.0100
1yr_24hr	1/1/1989	13:50	0.0100
1yr_24hr	1/1/1989	13:55	0.0100
1yr_24hr	1/1/1989	14:00	0.0100
1yr_24hr	1/1/1989	14:05	0.0100
1yr_24hr	1/1/1989	14:10	0.0100
1yr_24hr	1/1/1989	14:15	0.0100
1yr_24hr	1/1/1989	14:20	0.0100
1yr_24hr	1/1/1989	14:25	0.0100
1yr_24hr	1/1/1989	14:30	0.0100
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1yr_24hr	1/1/1989	14:40	0.0067
1yr_24hr	1/1/1989	14:45	0.0067
1yr_24hr	1/1/1989	14:50	0.0067
1yr_24hr	1/1/1989	14:55	0.0067
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1yr_24hr	1/1/1989	16:35	0.0058
1yr_24hr	1/1/1989	16:40	0.0058
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1yr_24hr	1/1/1989	16:55	0.0058
1yr_24hr	1/1/1989	17:00	0.0058
1yr_24hr	1/1/1989	17:05	0.0058
1yr_24hr	1/1/1989	17:10	0.0058
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1yr_24hr	1/1/1989	18:10	0.0025
1yr_24hr	1/1/1989	18:15	0.0025
1yr_24hr	1/1/1989	18:20	0.0025
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1yr_24hr	1/1/1989	18:45	0.0025
1yr_24hr	1/1/1989	18:50	0.0025
1yr_24hr	1/1/1989	18:55	0.0025
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1yr_24hr	1/1/1989	19:05	0.0025
1yr_24hr	1/1/1989	19:10	0.0025
1yr_24hr	1/1/1989	19:15	0.0025
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1yr_24hr	1/1/1989	19:50	0.0025
1yr_24hr	1/1/1989	19:55	0.0025
1yr_24hr	1/1/1989	20:00	0.0025
1yr_24hr	1/1/1989	20:05	0.0025
1yr_24hr	1/1/1989	20:10	0.0025
1yr_24hr	1/1/1989	20:15	0.0025

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1yr_24hr	1/1/1989	20:50	0.0025
1yr_24hr	1/1/1989	20:55	0.0025
1yr_24hr	1/1/1989	21:00	0.0025
1yr_24hr	1/1/1989	21:05	0.0025
1yr_24hr	1/1/1989	21:10	0.0025
1yr_24hr	1/1/1989	21:15	0.0025
1yr_24hr	1/1/1989	21:20	0.0025
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1yr_24hr	1/1/1989	21:50	0.0025
1yr_24hr	1/1/1989	21:55	0.0025
1yr_24hr	1/1/1989	22:00	0.0025
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1yr_24hr	1/1/1989	22:10	0.0025
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1yr_24hr	1/1/1989	23:55	0.0025
2yr_24hr	1/1/1989	0:00	0.0000
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2yr_24hr	1/1/1989	0:15	0.0025
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2yr_24hr	1/1/1989	3:45	0.0025
2yr_24hr	1/1/1989	3:50	0.0025
2yr_24hr	1/1/1989	3:55	0.0025
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2yr_24hr	1/1/1989	4:05	0.0025

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2yr_24hr	1/1/1989	4:15	0.0025
2yr_24hr	1/1/1989	4:20	0.0025
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2yr_24hr         1/1/1989   21:25      0.0025
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INPUT      YES
CONTROLS   NO
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]

[MAP]
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UNITS            Feet

[COORDINATES]
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;;--------------- ---------------- ----------------
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J2                1440552.217      478474.392
J3                1440696.956      479893.657
J4                1440856.524      478324.923
J5                1441361.86       477584.281
J6                1441953.504      478890.037
J7                1441923.895      479359.686
J8                1443960.932      479222.442
J9                1443385.705      478266.924
OF1               1442824.879      477617.825
OF2               1442132.936      477556.659
OF3               1442095.36       477541.59
OF4               1442453.174      477150.537
OF5               1442704.209      476763.4
OF6               1443259.46       478172.62
C-1               1442085.253      477711.628
C-3               1441256.812      477791.444
C-4               1442285.726      477073.524
C-5               1440681.707      479944.636
C-6               1440450.652      478550.611

[VERTICES]
;;Link            X-Coord          Y-Coord
;;--------------- ---------------- ----------------
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OR1               1441395.76       477723.443
W1                1441332.391      477707.33
W2                1441448.555      477739.504
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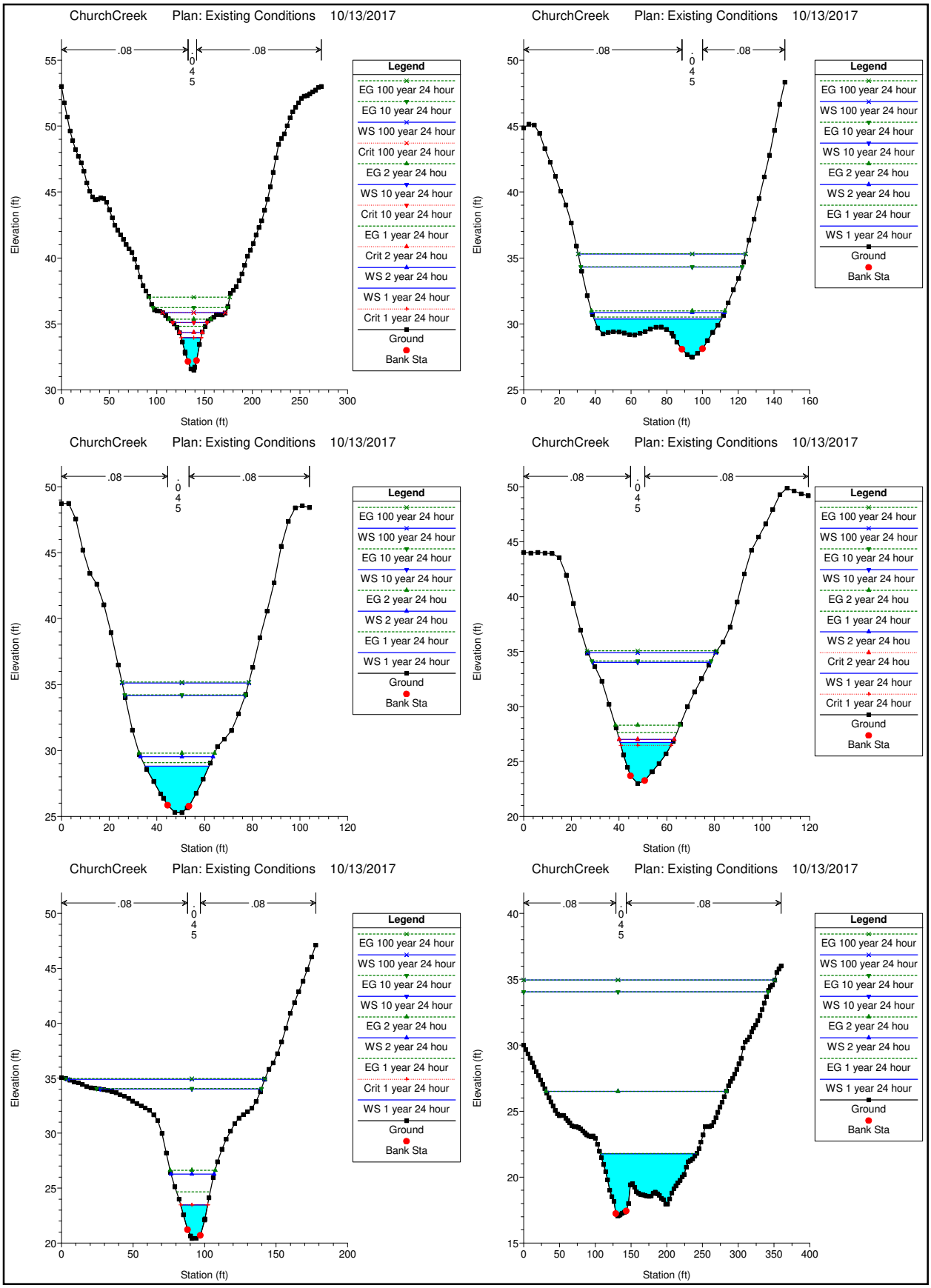
Appendix B. HEC-RAS Files


ChurchCreek Plan: Existing Conditions 10/13/2017
.08
.045
.08
Elevation (ft)
Station (ft)
Legend
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EG 10 year 24 hour
WS 100 year 24 hour
Crit 100 year 24 hour
EG 2 year 24 hou
WS 10 year 24 hour
Crit 10 year 24 hour
EG 1 year 24 hour
Crit 2 year 24 hou
WS 2 year 24 hou
WS 1 year 24 hour
Crit 1 year 24 hour
Ground
Bank Sta
ChurchCreek Plan: Existing Conditions 10/13/2017
.08
.045
.08
Elevation (ft)
Station (ft)
Legend
EG 100 year 24 hour
WS 100 year 24 hour
EG 10 year 24 hour
WS 10 year 24 hour
EG 2 year 24 hou
WS 2 year 24 hou
EG 1 year 24 hour
WS 1 year 24 hour
Ground
Bank Sta
ChurchCreek Plan: Existing Conditions 10/13/2017
.08
.045
.08
Elevation (ft)
Station (ft)
Legend
EG 100 year 24 hour
WS 100 year 24 hour
EG 10 year 24 hour
WS 10 year 24 hour
EG 2 year 24 hou
WS 2 year 24 hou
EG 1 year 24 hour
WS 1 year 24 hour
Ground
Bank Sta
ChurchCreek Plan: Existing Conditions 10/13/2017
.08
.045
.08
Elevation (ft)
Station (ft)
Legend
EG 100 year 24 hour
WS 100 year 24 hour
EG 10 year 24 hour
WS 10 year 24 hour
EG 2 year 24 hou
WS 2 year 24 hou
EG 1 year 24 hour
Crit 2 year 24 hou
WS 1 year 24 hour
Crit 1 year 24 hour
Ground
Bank Sta
ChurchCreek Plan: Existing Conditions 10/13/2017
.08
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Elevation (ft)
Station (ft)
Legend
EG 100 year 24 hour
WS 100 year 24 hour
EG 10 year 24 hour
WS 10 year 24 hour
EG 2 year 24 hou
WS 2 year 24 hou
EG 1 year 24 hour
Crit 1 year 24 hour
WS 1 year 24 hour
Ground
Bank Sta
ChurchCreek Plan: Existing Conditions 10/13/2017
.08
.045
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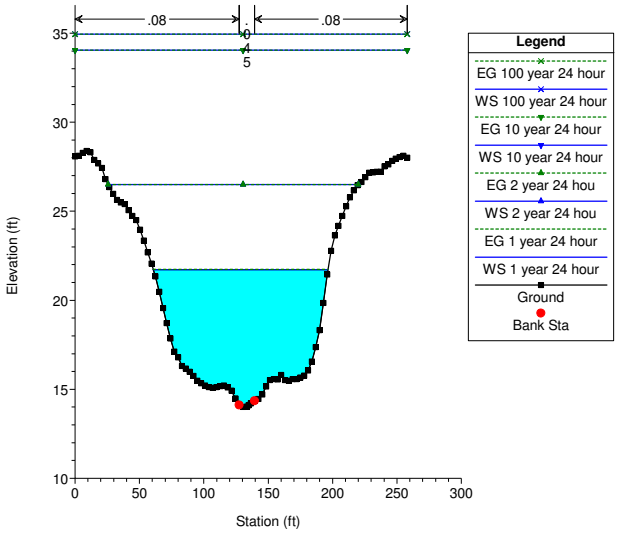
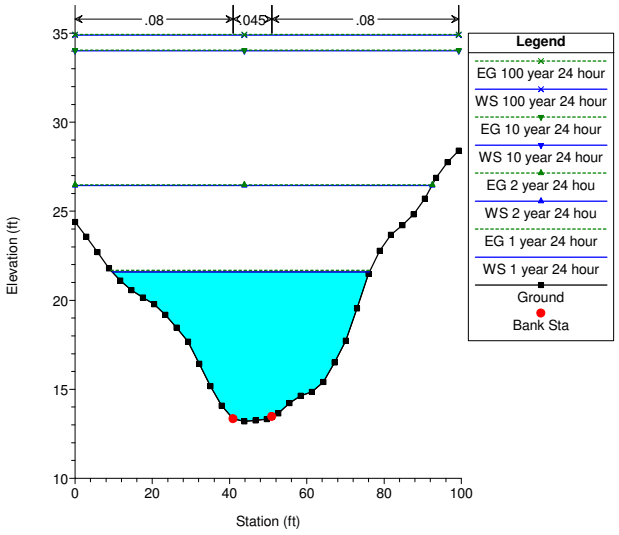
Elevation (ft)
Station (ft)
Legend
EG 100 year 24 hour
WS 100 year 24 hour
EG 10 year 24 hour
WS 10 year 24 hour
EG 2 year 24 hou
WS 2 year 24 hou
EG 1 year 24 hour
WS 1 year 24 hour
Ground
Bank Sta

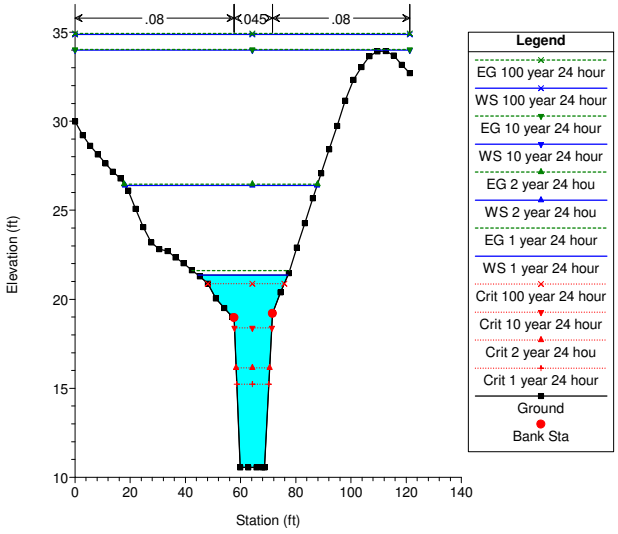
ChurchCreek Plan: Existing Conditions 10/13/2017



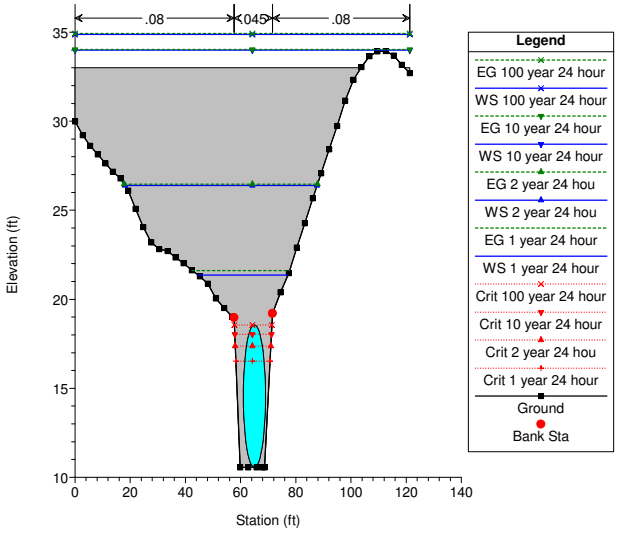
ChurchCreek Plan: Existing Conditions 10/13/2017



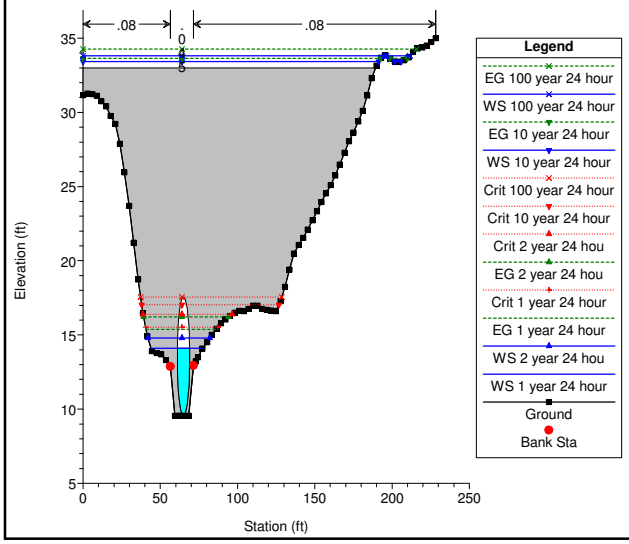
ChurchCreek Plan: Existing Conditions 10/13/2017



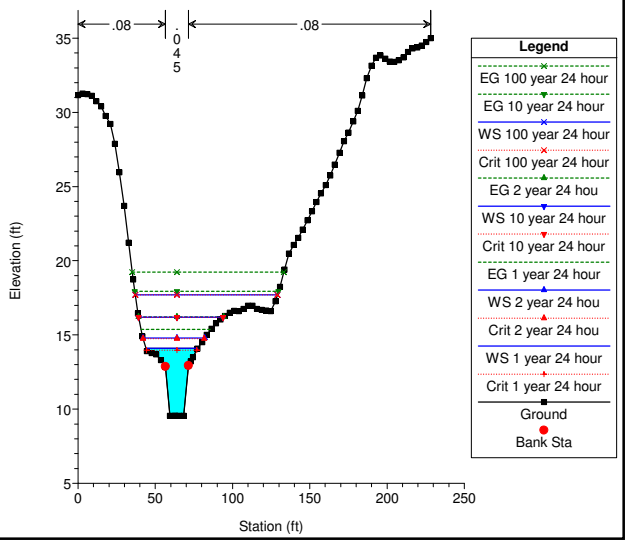
ChurchCreek Plan: Existing Conditions 10/13/2017

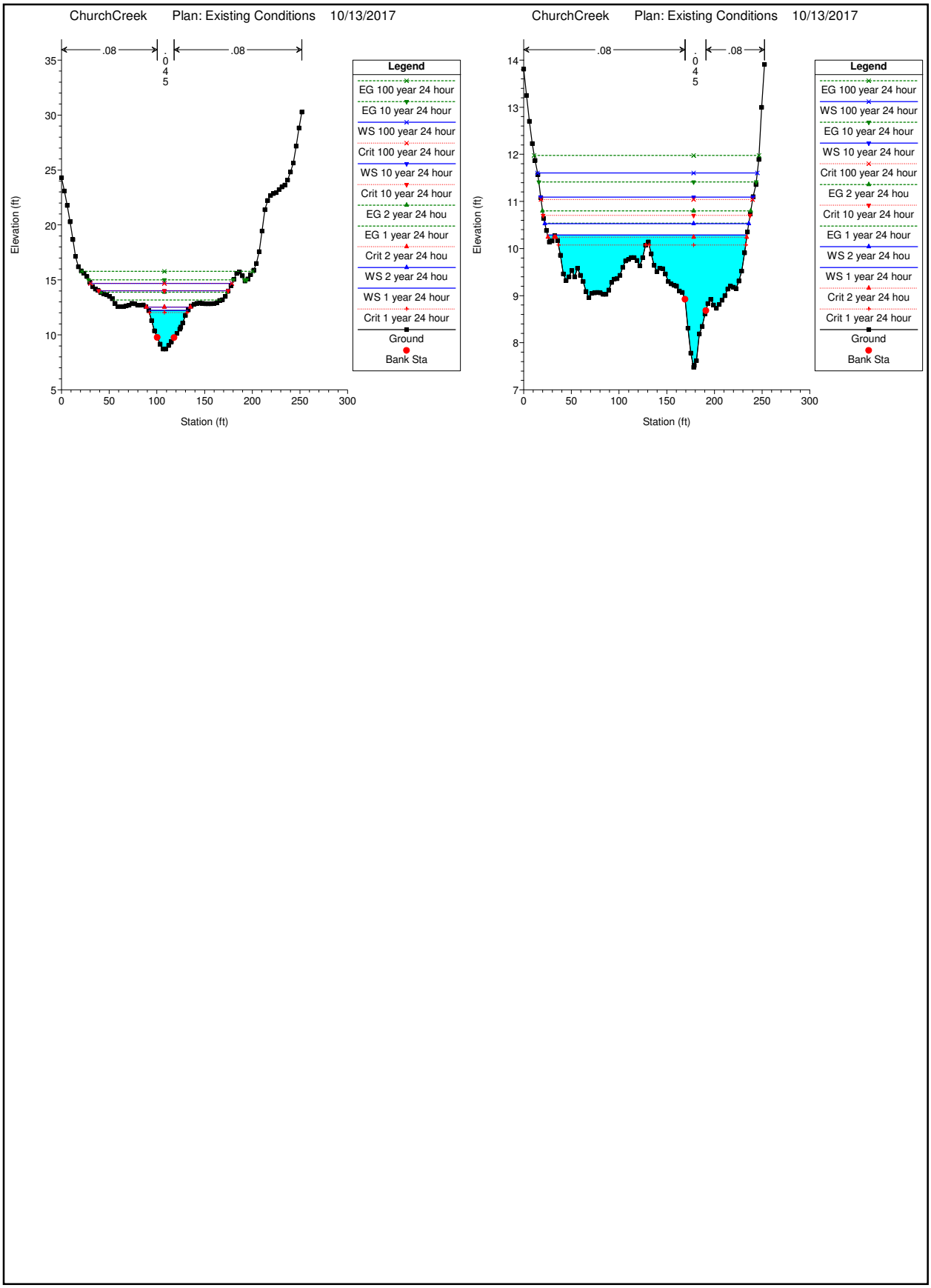


ChurchCreek Plan: Existing Conditions 10/13/2017



ChurchCreek Plan: Existing Conditions 10/13/2017




ChurchCreek Plan: Existing Conditions 10/13/2017
.08
.045
.08
Elevation (ft)
Station (ft)
Legend
EG 100 year 24 hour
EG 10 year 24 hour
WS 100 year 24 hour
Crit 100 year 24 hour
WS 10 year 24 hour
Crit 10 year 24 hour
EG 2 year 24 hou
EG 1 year 24 hour
Crit 2 year 24 hou
WS 2 year 24 hou
WS 1 year 24 hour
Crit 1 year 24 hour
Ground
Bank Sta
ChurchCreek Plan: Existing Conditions 10/13/2017
.08
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Elevation (ft)
Station (ft)
Legend
EG 100 year 24 hour
WS 100 year 24 hour
EG 10 year 24 hour
WS 10 year 24 hour
Crit 100 year 24 hour
EG 2 year 24 hou
Crit 10 year 24 hour
EG 1 year 24 hour
WS 2 year 24 hou
WS 1 year 24 hour
Crit 2 year 24 hou
Crit 1 year 24 hour
Ground
Bank Sta

HEC-RAS Version 4.1.0 Jan 2010
U.S. Army Corps of Engineers
Hydrologic Engineering Center
609 Second Street
Davis, California

```
X   X XXXXXX  XXXX     XXXX    XX    XXXX
X   X X     X  X    X  X   X X  X
X   X X     X      X  X   X  X  X
XXXXXXX XXXX   X    XXX XXXX   XXXXXX  XXXX
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X   X XXXXXX  XXXX    X  X  X  X  XXXXX
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PROJECT DATA
Project Title: ChurchCreek
Project File : ChurchCreek.prj
Run Date and Time: 10/13/2017 10:26:16 AM

Project in English units

PLAN DATA

Plan Title: Existing Conditions
Plan File : j:\ANMS4\HH_Task\Hydraulics\HECRAS\model\CC\ChurchCreek.p01

Geometry Title: PSB GeoRAS
Geometry File : j:\ANMS4\HH_Task\Hydraulics\HECRAS\model\CC\ChurchCreek.g01

Flow Title : SWMM Model Flows
Flow File : j:\ANMS4\HH_Task\Hydraulics\HECRAS\model\CC\ChurchCreek.f01

Plan Summary Information:
Number of: Cross Sections = 12 Multiple Openings = 0
Culverts = 1 Inline Structures = 0
Bridges = 0 Lateral Structures = 0

Computational Information
Water surface calculation tolerance = 0.01
Critical depth calculation tolerance = 0.01
Maximum number of iterations = 20
Maximum difference tolerance = 0.3
Flow tolerance factor = 0.001

Computation Options
Critical depth computed only where necessary

Conveyance Calculation Method: At breaks in n values only
Friction Slope Method: Average Conveyance
Computational Flow Regime: Subcritical Flow

FLOW DATA

Flow Title: SWMM Model Flows
Flow File : j:\ANMS4\HH_Task\Hydraulics\HECRAS\model\CC\ChurchCreek.f01

Flow Data (cfs)

River	Reach	RS	1 year 24 hour	2 year 24 hou	10 year 24 hour	100 year 24 hour
ChurchCrk	Reach1	2442	183	247	371	521
ChurchCrk	Reach1	1664	280	374	558	781
ChurchCrk	Reach1	942	539	723	1247	1833
ChurchCrk	Reach1	654	548	734	1263	1856

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
ChurchCrk	Reach1	1 year 24 hour		Normal S = 0.01
ChurchCrk	Reach1	2 year 24 hou		Normal S = 0.01
ChurchCrk	Reach1	10 year 24 hour		Normal S = 0.01
ChurchCrk	Reach1	100 year 24 hour		Normal S = 0.01

GEOMETRY DATA

Geometry Title: PSB GeoRAS
Geometry File : j:\ANMS4\HH_Task\Hydraulics\HECRAS\model\CC\ChurchCreek.g01

CROSS SECTION

RIVER: ChurchCrk
REACH: Reach1 RS: 2442

INPUT
Description:
Station Elevation Data num= 95

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	53	2.95	51.77	5.9	50.69	8.85	49.62	11.8	48.9
14.74	48.22	17.69	47.7	20.64	47.21	23.59	46.57	26.54	45.69
29.49	45.07	32.44	44.63	35.39	44.41	38.34	44.45	41.28	44.55
44.23	44.51	47.18	44.21	50.13	43.64	53.08	43.05	56.03	42.47
58.98	42.12	61.93	41.76	64.88	41.39	67.83	41.02	70.77	40.7
73.72	40.43	76.67	39.91	79.62	39.3	82.57	38.56	85.52	37.9

88.47 37.5 91.42 37.08 94.36 36.47 97.31 36.06 100.26 35.99
103.21 35.97 106.16 35.86 109.11 35.62 112.06 35.39 115.01 35.23
117.96 35 120.93 34.7 123.89 34.34 126.86 33.63 129.53 32.85
129.83 32.76 132.8 32.13 135.77 31.59 138.74 31.49 139.67 31.72
141.7 32.21 144.67 33.44 147.64 34.38 150.61 34.82 153.58 35.23
156.55 35.36 159.52 35.5 162.48 35.72 165.45 35.72 168.42 35.68
171.39 35.82 174.36 36.33 177.33 37.29 180.3 37.55 183.26 37.84
186.23 38.28 189.2 38.78 192.17 39.44 195.14 40.14 198.11 40.58
201.08 41.11 204.04 41.73 207.01 42.32 209.98 42.81 212.95 43.62
215.92 44.44 218.89 45.38 221.86 46.49 224.82 47.6 227.79 48.6
230.76 49.07 233.73 49.41 236.7 50.03 239.67 50.63 242.63 51.08
245.6 51.42 248.57 51.76 251.54 52.11 254.51 52.26 257.48 52.31
260.45 52.44 263.41 52.59 266.38 52.74 269.35 52.94 272.32 53

Manning's n Values num= 3
Sta n Val Sta n Val Sta n Val
0 .08 132.8 .045 141.7 .08

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
132.8 141.7 225.53 232.08 237.13 .1 .3

CROSS SECTION

RIVER: ChurchCrk
REACH: Reach1 RS: 2210

INPUT
Description:
Station Elevation Data num= 53
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
0 44.86 2.96 45.15 5.91 45.08 8.87 44.43 11.83 43.29
14.79 42.26 17.74 41.17 20.7 40.06 23.66 39.01 26.62 37.65
29.57 35.89 32.53 33.98 35.49 32.13 38.45 30.71 41.4 29.69
44.36 29.25 47.32 29.35 50.28 29.41 53.23 29.38 56.19 29.31
59.15 29.18 62.1 29.15 65.06 29.28 68.02 29.43 70.98 29.6
73.93 29.75 76.89 29.77 79.85 29.59 82.81 29.28 83.72 29.07
85.68 28.61 88.56 28.08 91.43 27.67 93.84 27.5 94.31 27.47
97.18 27.76 100.06 28.11 102.93 28.74 105.81 29.37 108.68 29.89
111.56 30.63 114.43 31.59 117.31 32.59 120.18 33.44 123.06 34.7
125.93 36.34 128.81 37.94 131.68 39.51 134.55 41.14 137.43 42.8
140.3 44.67 143.18 46.66 146.05 48.32

Manning's n Values num= 3
Sta n Val Sta n Val Sta n Val
0 .08 88.56 .045 100.06 .08

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
88.56 100.06 376.59 371.84 368.59 .1 .3

CROSS SECTION

RIVER: ChurchCrk

REACH: Reach1 RS: 1838

INPUT
Description:
Station Elevation Data num= 38

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	48.73	2.97	48.74	5.94	47.56	8.92	45.2	11.89	43.42
14.86	42.62	17.83	41.05	20.8	38.93	23.77	36.48	26.75	34.02
29.72	31.55	32.69	29.69	35.66	28.57	38.63	27.65	41.6	26.71
42.71	26.39	44.58	25.84	47.55	25.3	50.52	25.29	52.72	25.65
53.49	25.77	56.46	26.74	59.43	27.82	62.41	29.04	65.38	30.31
68.35	30.86	71.32	31.5	74.29	32.78	77.27	34.25	80.24	36.31
83.21	38.55	86.18	40.56	89.15	42.72	92.12	45.48	95.1	47.37
98.07	48.4	101.04	48.56	104.01	48.42				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.08	44.58	.045	53.49	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
44.58	53.49	173.88	173.98	174.09	.1	.3

CROSS SECTION

RIVER: ChurchCrk
REACH: Reach1 RS: 1664

INPUT
Description:
Station Elevation Data num= 43

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	44.02	2.99	43.97	5.97	44.02	8.96	43.97	11.95	43.91
14.93	43.55	17.92	41.95	20.9	39.39	23.89	36.96	26.88	34.88
29.86	33.65	32.85	32.29	35.84	30.21	38.82	28.06	41.81	25.58
43.57	24.47	44.79	23.69	47.78	23	50.77	23.25	53.75	24.05
53.85	24.07	56.74	24.82	59.73	25.69	62.71	26.81	65.7	28.4
68.68	29.99	71.67	31.32	74.66	32.54	77.64	33.75	80.63	34.96
83.62	35.87	86.6	37.23	89.59	39.51	92.57	42.07	95.56	44.23
98.55	45.43	101.53	46.62	104.52	47.94	107.51	49.28	110.49	49.87
113.48	49.62	116.46	49.36	119.45	49.19				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.08	44.79	.045	50.77	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
44.79	50.77	173.7	175.5	177.29	.1	.3

CROSS SECTION

RIVER: ChurchCrk
REACH: Reach1 RS: 1489

INPUT
Description:
Station Elevation Data num= 63

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	35.06	2.93	34.98	5.85	34.81	8.78	34.67	11.71	34.57
14.63	34.42	17.56	34.24	20.49	34.13	23.41	34.09	26.34	34.03
29.27	33.96	32.19	33.9	35.12	33.81	38.05	33.68	40.97	33.51
43.9	33.34	46.83	33.15	49.75	32.92	52.68	32.7	55.6	32.49
58.53	32.3	61.46	32.07	64.38	31.67	67.31	31.14	70.3	29.96
73.28	28.19	76.27	26.41	79.25	25.11	82.24	23.99	85.23	22.56
88.21	21.21	90.29	20.64	91.2	20.4	94.18	20.43	97.17	20.69
100.16	22.09	100.31	22.2	103.14	24.11	106.13	25.98	109.11	27.4
112.1	28.54	115.08	29.45	118.07	30.19	121.06	30.87	124.04	31.37
127.03	31.69	130.01	31.95	133	32.28	135.99	32.88	138.97	33.75
141.96	34.9	144.94	35.8	147.93	36.39	150.92	37.23	153.9	38.32
156.89	39.55	159.87	40.89	162.86	41.9	165.84	42.88	168.83	43.84
171.82	44.88	174.8	46.03	177.79	47.12				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.08	88.21	.045	97.17	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
88.21	97.17	224.06	226.16	226.11	.1	.3

CROSS SECTION

RIVER: ChurchCrk
REACH: Reach1 RS: 1263

INPUT
Description:
Station Elevation Data num= 126

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	30	2.94	29.67	5.89	29.34	8.83	29.01	11.77	28.68
14.71	28.35	17.66	28.02	20.6	27.69	23.54	27.36	26.49	27.03
29.43	26.7	32.37	26.37	35.31	26.04	38.26	25.71	41.2	25.38
44.14	25.05	47.08	24.79	50.03	24.65	52.97	24.68	55.91	24.67
58.86	24.46	61.8	24.29	64.74	24.11	67.68	23.9	70.63	23.83
73.57	23.82	76.51	23.76	79.46	23.66	82.4	23.5	85.34	23.35
88.28	23.2	91.23	23.12	94.17	23.06	97.11	23.12	100.06	22.94
103	22.49	105.94	21.95	108.83	21.49	111.71	20.95	114.6	20.41
117.48	19.8	120.36	19.01	123.25	18.52	126.13	18.15	129.02	17.23
131.9	17.06	133.34	17.1	134.79	17.15	137.67	17.25	140.56	17.33
143.42	17.42	143.44	17.42	146.33	18	149.23	19.43	152.12	19.52
155.01	19.23	157.9	18.89	160.8	18.75	163.69	18.69	166.58	18.65
169.48	18.62	172.37	18.56	175.26	18.54	178.15	18.56	181.05	18.76
183.94	18.87	186.83	18.74	189.73	18.62	192.62	18.38	195.51	18.29
198.4	17.95	201.3	17.97	204.19	18.35	207.08	18.79	209.98	19.11
212.87	19.34	215.76	19.56	218.65	19.77	221.55	20.01	224.49	20.22
227.43	20.75	230.37	21.16	233.32	21.25	236.26	21.38	239.2	21.6
242.15	21.8	245.09	22.18	248.03	22.65	250.97	23.19	253.92	23.82

256.86 23.84 259.8 23.83 262.74 23.92 265.69 24.16 268.63 24.51
271.57 24.92 274.51 25.31 277.46 25.67 280.4 26.1 283.34 26.52
286.28 26.94 289.23 27.24 292.17 27.5 295.11 27.81 298.05 28.17
301 28.58 303.94 29.02 306.88 29.79 309.83 30.24 312.77 30.4
315.71 30.64 318.65 31.01 321.6 31.31 324.54 31.53 327.48 31.87
330.42 32.24 333.37 32.7 336.31 33.19 339.25 33.67 342.19 34.15
345.14 34.43 348.08 34.57 351.02 34.93 353.96 35.52 356.91 35.78
359.85 36.01

Manning's n Values num= 3
Sta n Val Sta n Val Sta n Val
0 .08 129.02 .045 143.44 .08

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
129.02 143.44 210.32 320.95 333.63 .1 .3

CROSS SECTION

RIVER: ChurchCrk
REACH: Reach1 RS: 942

INPUT
Description:
Station Elevation Data num= 90
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
0 28.08 2.97 28.12 5.93 28.28 8.9 28.39 11.87 28.32
14.83 27.89 17.8 27.68 20.76 27.43 23.73 26.8 26.7 26.35
29.66 25.98 32.63 25.64 35.6 25.49 38.56 25.4 41.53 25.06
44.5 24.74 47.46 24.51 50.43 23.97 53.39 23.36 56.36 22.68
59.33 22.06 62.29 21.34 65.26 20.47 68.23 19.56 71.19 18.71
74.16 17.86 77.13 17.11 80.09 16.8 83.06 16.31 86.02 16.16
88.99 15.98 91.96 15.76 94.92 15.49 97.89 15.34 100.86 15.22
103.82 15.12 106.79 15.09 109.76 15.12 112.72 15.18 115.69 15.21
118.65 15.11 121.62 14.93 124.59 14.47 124.61 14.47 127.55 14.12
130.52 14 133.49 14.02 134.69 14.1 136.45 14.21 139.42 14.35
142.39 14.45 145.35 14.71 148.32 15.16 151.28 15.51 154.25 15.57
157.22 15.55 160.18 15.81 163.15 15.52 166.12 15.48 169.08 15.58
172.05 15.58 175.01 15.67 177.98 15.77 180.95 16.06 183.91 16.56
186.88 17.36 189.85 18.33 192.81 19.85 195.78 21.44 198.75 22.77
201.71 23.64 204.68 24.18 207.65 24.74 210.61 25.27 213.58 25.78
216.54 26.17 219.51 26.47 222.48 26.64 225.44 26.91 228.41 27.17
231.38 27.19 234.34 27.22 237.31 27.22 240.28 27.53 243.24 27.64
246.21 27.83 249.17 27.96 252.14 28.05 255.11 28.11 258.07 28

Manning's n Values num= 3
Sta n Val Sta n Val Sta n Val
0 .08 127.55 .045 139.42 .08

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
127.55 139.42 254.95 241.84 232.76 .1 .3

CROSS SECTION

RIVER: ChurchCrk
REACH: Reach1 RS: 700

INPUT
Description:
Station Elevation Data num= 37

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	24.39	2.92	23.57	5.84	22.71	8.76	21.79	11.69	21.11
14.61	20.57	17.53	20.15	20.45	19.78	23.37	19.18	26.29	18.46
29.21	17.67	32.13	16.43	35.06	15.18	37.98	14.08	40.9	13.34
40.95	13.34	43.82	13.2	46.74	13.26	49.66	13.33	50.98	13.47
52.58	13.65	55.51	14.23	58.43	14.63	61.35	14.85	64.27	15.41
67.19	16.51	70.11	17.72	73.03	19.55	75.95	21.49	78.88	22.77
81.8	23.67	84.72	24.21	87.64	24.82	90.56	25.7	93.48	26.87
96.4	27.76	99.32	28.41						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.08	40.95	.045	50.98	.08

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

Left	Right	Left	Channel	Right	Coeff	Contr.	Expan.
40.95	50.98	36.13	45.54	54.7	.1	.3	

CROSS SECTION

RIVER: ChurchCrk
REACH: Reach1 RS: 654

INPUT
Description:
Station Elevation Data num= 45

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	29.99	2.75	29.21	5.49	28.62	8.24	28.13	10.98	27.64
13.73	27.16	16.47	26.78	19.22	26.1	21.96	25.08	24.71	24.05
27.64	23.2	30.56	22.81	33.49	22.7	36.42	22.34	39.35	22.03
42.28	21.63	45.21	21.28	48.14	20.88	51.07	20.05	54	19.5
56.93	19.03	57.6	18.96	59.86	10.56	62.79	10.56	65.72	10.56
67.81	10.56	68.64	10.56	71.57	19.21	74.5	20.38	77.43	21.47
80.36	22.9	83.29	24.27	86.22	25.68	89.15	27.08	92.08	28.42
95.01	29.73	97.94	31.15	100.87	32.32	103.79	33.04	106.72	33.66
109.65	33.92	112.58	33.94	115.51	33.68	118.44	33.16	121.37	32.7

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.08	57.6	.045	71.57	.08

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

Left	Right	Left	Channel	Right	Coeff	Contr.	Expan.
57.6	71.57	217.43	223.71	229.88	.1	.3	

CULVERT

RIVER: ChurchCrk
REACH: Reach1 RS: 595

INPUT
Description:
Distance from Upstream XS = 60
Deck/Roadway Width = 105
Weir Coefficient = 2.6
Upstream Deck/Roadway Coordinates
num= 2
Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord
0 33 150 33

Upstream Bridge Cross Section Data
Station Elevation Data num= 45
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
0 29.99 2.75 29.21 5.49 28.62 8.24 28.13 10.98 27.64
13.73 27.16 16.47 26.78 19.22 26.1 21.96 25.08 24.71 24.05
27.64 23.2 30.56 22.81 33.49 22.7 36.42 22.34 39.35 22.03
42.28 21.63 45.21 21.28 48.14 20.88 51.07 20.05 54 19.5
56.93 19.03 57.6 18.96 59.86 10.56 62.79 10.56 65.72 10.56
67.81 10.56 68.64 10.56 71.57 19.21 74.5 20.38 77.43 21.47
80.36 22.9 83.29 24.27 86.22 25.68 89.15 27.08 92.08 28.42
95.01 29.73 97.94 31.15 100.87 32.32 103.79 33.04 106.72 33.66
109.65 33.92 112.58 33.94 115.51 33.68 118.44 33.16 121.37 32.7

Manning's n Values num= 3
Sta n Val Sta n Val Sta n Val
0 .08 57.6 .045 71.57 .08

Bank Sta: Left Right Coeff Contr. Expan.
57.6 71.57 .1 .3

Downstream Deck/Roadway Coordinates
num= 2
Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord
0 33 250 33

Downstream Bridge Cross Section Data
Station Elevation Data num= 80
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
0 31.16 2.98 31.26 5.95 31.23 8.93 31.12 11.9 30.76
14.88 30.41 17.85 29.75 20.83 29.21 23.8 27.89 26.78 25.96
29.75 23.69 32.73 21.22 35.7 18.73 38.68 16.45 41.65 14.89
44.63 13.9 47.6 13.77 50.58 13.69 53.55 13.31 56.53 12.88
59.5 9.56 62.48 9.56 62.87 9.56 65.46 9.56 68.43 9.56
71.41 12.93 72.87 13.21 74.38 13.5 77.36 14.07 80.33 14.52
83.31 15 86.27 15.41 89.23 15.79 92.19 16.04 95.15 16.29
98.11 16.49 101.07 16.63 104.03 16.61 106.99 16.75 109.95 16.98
112.91 16.97 115.87 16.76 118.83 16.68 121.79 16.65 124.75 16.6
127.71 17.28 130.67 18.25 133.63 19.41 136.59 20.49 139.55 21.06
142.51 21.54 145.47 22.11 148.43 22.73 151.39 23.34 154.35 23.96
157.31 24.54 160.27 25.1 163.23 25.74 166.19 26.48 169.15 27.28
172.11 28.06 175.07 28.64 178.03 29.4 180.99 30.1 183.95 31.14

186.91 32.31 189.87 33.14 192.83 33.69 195.79 33.84 198.75 33.63
201.71 33.43 204.67 33.4 207.63 33.52 210.59 33.7 213.55 34.07
216.51 34.32 219.47 34.38 222.43 34.5 225.39 34.74 228.35 35

Manning's n Values num= 3
Sta n Val Sta n Val Sta n Val
0 .08 56.53 .045 71.41 .08

Bank Sta: Left Right Coeff Contr. Expan.
56.53 71.41 .1 .3

Upstream Embankment side slope = 0 horiz. to 1.0 vertical
Downstream Embankment side slope = 0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow = .98
Elevation at which weir flow begins =
Energy head used in spillway design =
Spillway height used in design =
Weir crest shape = Broad Crested

Number of Culverts = 1

Culvert Name Shape Rise Span
Culvert #1 Circular 8
FHWA Chart # 2 - Corrugated Metal Pipe Culvert
FHWA Scale # 2 - Mitered to conform to slope
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist Length Top n Bottom n Depth Blocked Entrance Loss Coef Exit Loss Coef
5 148 .024 .013 0 .7 1
Upstream Elevation = 10.56
Centerline Station = 65
Downstream Elevation = 9.56
Centerline Station = 65

CROSS SECTION

RIVER: ChurchCrk
REACH: Reach1 RS: 431

INPUT
Description:
Station Elevation Data num= 80
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
0 31.16 2.98 31.26 5.95 31.23 8.93 31.12 11.9 30.76
14.88 30.41 17.85 29.75 20.83 29.21 23.8 27.89 26.78 25.96
29.75 23.69 32.73 21.22 35.7 18.73 38.68 16.45 41.65 14.89
44.63 13.9 47.6 13.77 50.58 13.69 53.55 13.31 56.53 12.88
59.5 9.56 62.48 9.56 62.87 9.56 65.46 9.56 68.43 9.56
71.41 12.93 72.87 13.21 74.38 13.5 77.36 14.07 80.33 14.52
83.31 15 86.27 15.41 89.23 15.79 92.19 16.04 95.15 16.29
98.11 16.49 101.07 16.63 104.03 16.61 106.99 16.75 109.95 16.98
112.91 16.97 115.87 16.76 118.83 16.68 121.79 16.65 124.75 16.6
127.71 17.28 130.67 18.25 133.63 19.41 136.59 20.49 139.55 21.06
142.51 21.54 145.47 22.11 148.43 22.73 151.39 23.34 154.35 23.96

157.31 24.54 160.27 25.1 163.23 25.74 166.19 26.48 169.15 27.28
172.11 28.06 175.07 28.64 178.03 29.4 180.99 30.1 183.95 31.14
186.91 32.31 189.87 33.14 192.83 33.69 195.79 33.84 198.75 33.63
201.71 33.43 204.67 33.4 207.63 33.52 210.59 33.7 213.55 34.07
216.51 34.32 219.47 34.38 222.43 34.5 225.39 34.74 228.35 35

Manning's n Values num= 3
Sta n Val Sta n Val Sta n Val
0 .08 56.53 .045 71.41 .08

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
56.53 71.41 137.98 136.16 134.34 .1 .3

CROSS SECTION

RIVER: ChurchCrk
REACH: Reach1 RS: 295

INPUT
Description:
Station Elevation Data num= 88
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
0 24.3 2.95 23.09 5.91 21.79 8.86 20.29 11.81 18.68
14.77 17.14 17.72 16.2 20.67 15.82 23.63 15.62 26.58 15.3
29.53 14.82 32.49 14.39 35.44 14.17 38.39 14.06 41.35 13.84
44.3 13.74 47.25 13.65 50.21 13.5 53.16 13.28 56.11 12.88
59.07 12.57 62.02 12.56 64.97 12.57 67.93 12.64 70.88 12.7
73.83 12.88 76.79 12.83 79.74 12.7 82.69 12.69 85.65 12.72
88.6 12.57 91.55 12.2 94.51 11.29 97.46 10.36 100.41 9.77
103.37 9.17 106.32 8.7 109.27 8.7 112.23 9.04 114.99 9.36
115.18 9.38 118.13 9.75 121.09 10.14 124.04 10.52 125.01 10.71
126.99 11.08 129.95 11.77 132.9 12.27 135.88 12.61 138.86 12.78
141.84 12.88 144.82 12.89 147.8 12.87 150.78 12.83 153.76 12.82
156.74 12.82 159.72 12.84 162.7 12.92 165.68 13.14 168.66 13.19
171.64 13.5 174.62 13.99 177.6 14.49 180.58 15.06 183.56 15.59
186.54 15.72 189.52 15.37 192.5 14.89 195.48 15.1 198.46 15.49
201.45 15.9 204.43 16.49 207.41 17.57 210.39 19.44 213.37 21.39
216.35 22.23 219.33 22.68 222.31 22.85 225.29 22.94 228.27 23.23
231.25 23.47 234.23 23.63 237.21 24.09 240.19 24.81 243.17 25.63
246.15 27.18 249.13 28.83 252.11 30.27

Manning's n Values num= 3
Sta n Val Sta n Val Sta n Val
0 .08 100.41 .045 118.13 .08

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
100.41 118.13 209.15 202.38 195.36 .1 .3

CROSS SECTION

RIVER: ChurchCrk
REACH: Reach1 RS: 92

INPUT
Description:
Station Elevation Data num= 88

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	13.81	2.97	13.25	5.94	12.7	8.91	12.23	11.88	11.87
14.85	11.57	17.83	11.08	20.8	10.64	23.77	10.38	26.74	10.14
29.71	10.16	32.68	10.27	35.65	10.17	38.62	9.86	41.59	9.46
44.56	9.32	47.53	9.4	50.51	9.53	53.48	9.4	56.45	9.58
59.42	9.43	62.39	9.3	65.36	9.09	68.33	8.96	71.3	9.05
74.27	9.06	77.24	9.07	80.21	9.06	83.19	9.03	86.16	9.03
89.13	9.12	92.1	9.28	95.07	9.35	98.04	9.36	101.01	9.43
103.98	9.6	106.95	9.74	109.92	9.77	112.89	9.81	115.87	9.81
118.84	9.75	121.81	9.63	124.78	9.81	127.75	10.07	130.72	10.14
133.69	9.89	136.66	9.64	139.63	9.51	142.6	9.58	145.57	9.57
148.55	9.46	151.52	9.3	154.49	9.25	157.46	9.22	160.43	9.2
163.4	9.1	166.37	9.07	169.34	8.92	172.31	8.31	175.28	7.78
178.25	7.48	179.03	7.52	181.23	7.62	184.2	8.19	187.17	8.35
190.14	8.61	191.16	8.68	193.11	8.83	196.08	8.92	199.05	8.8
202.02	8.73	204.99	8.81	207.96	8.9	210.93	9	213.91	9.14
216.88	9.2	219.85	9.18	222.82	9.15	225.79	9.31	228.76	9.52
231.73	9.91	234.7	10.35	237.67	10.74	240.64	11.1	243.62	11.36
246.59	11.89	249.56	13	252.53	13.91				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.08	169.34	.045	191.16	.08

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
169.34 191.16 92.94 92.25 91.79 .1 .3

SUMMARY OF MANNING'S N VALUES

River:ChurchCrk

Reach	River Sta.	n1	n2	n3
Reach1	2442	.08	.045	.08
Reach1	2210	.08	.045	.08
Reach1	1838	.08	.045	.08
Reach1	1664	.08	.045	.08
Reach1	1489	.08	.045	.08
Reach1	1263	.08	.045	.08
Reach1	942	.08	.045	.08
Reach1	700	.08	.045	.08
Reach1	654	.08	.045	.08
Reach1	595	Culvert		
Reach1	431	.08	.045	.08
Reach1	295	.08	.045	.08
Reach1	92	.08	.045	.08

SUMMARY OF REACH LENGTHS

River: ChurchCrk

Reach	River Sta.	Left	Channel	Right
Reach1	2442	225.53	232.08	237.13
Reach1	2210	376.59	371.84	368.59
Reach1	1838	173.88	173.98	174.09
Reach1	1664	173.7	175.5	177.29
Reach1	1489	224.06	226.16	226.11
Reach1	1263	210.32	320.95	333.63
Reach1	942	254.95	241.84	232.76
Reach1	700	36.13	45.54	54.7
Reach1	654	217.43	223.71	229.88
Reach1	595	Culvert		
Reach1	431	137.98	136.16	134.34
Reach1	295	209.15	202.38	195.36
Reach1	92	92.94	92.25	91.79

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: ChurchCrk

Reach	River Sta.	Contr.	Expan.
Reach1	2442	.1	.3
Reach1	2210	.1	.3
Reach1	1838	.1	.3
Reach1	1664	.1	.3
Reach1	1489	.1	.3
Reach1	1263	.1	.3
Reach1	942	.1	.3
Reach1	700	.1	.3
Reach1	654	.1	.3
Reach1	595	Culvert	
Reach1	431	.1	.3
Reach1	295	.1	.3
Reach1	92	.1	.3

HEC-RAS Version 4.1.0 Jan 2010
U.S. Army Corps of Engineers
Hydrologic Engineering Center
609 Second Street
Davis, California

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X   X XXXXXX  XXXX     XXXX     XX    XXXX
X   X X      X   X    X  X   X X  X
X   X X      X       X  X   X   X  X
XXXXXXX XXXX   X    XXX XXXX   XXXXXX  XXXX
X   X X      X       X X   X   X     X
X   X X      X   X    X  X   X   X     X
X   X XXXXXX  XXXX     X   X  X   X  XXXXX
```

PROJECT DATA
Project Title: ChurchCreek
Project File : ChurchCreek.prj
Run Date and Time: 10/31/2017 1:22:43 PM

Project in English units

Profile Output Table - Standard Table 1

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft/ft)	E.G. Slope (ft/s)	Vel Chnl (sq ft)	Flow Area	Top Width (ft)	Froude # Chl
Reach1	2442	1 year 24 hour	183.00000	31.49	33.96	33.96	34.82	0.020560	7.96	30.52	20.85	0.94
Reach1	2442	2 year 24 hou	247.00000	31.49	34.35	34.35	35.36	0.020288	8.80	39.14	23.73	0.96
Reach1	2442	10 year 24 hour	371.00000	31.49	35.10	35.10	36.24	0.017371	9.64	61.23	35.95	0.93
Reach1	2442	100 year 24 hour	521.00000	31.49	35.86	35.86	37.03	0.014606	10.14	98.51	65.55	0.88
Reach1	2210	1 year 24 hour	183.00000	27.47	30.37		30.51	0.003581	3.74	92.02	71.13	0.41
Reach1	2210	2 year 24 hou	247.00000	27.47	30.85		30.98	0.002799	3.70	127.09	74.08	0.37
Reach1	2210	10 year 24 hour	371.00000	27.47	34.31		34.33	0.000220	1.71	411.84	90.14	0.12
Reach1	2210	100 year 24 hour	521.00000	27.47	35.29		35.32	0.000243	1.97	502.36	93.60	0.13
Reach1	1838	1 year 24 hour	183.00000	25.29	28.82		29.09	0.004071	4.69	57.85	26.86	0.45
Reach1	1838	2 year 24 hou	247.00000	25.29	29.52		29.81	0.003476	4.92			

78.11 30.41 0.43
Reach1 1838 10 year 24 hour 371.00000 25.29 34.16 34.22 0.000336 2.54
271.14 50.52 0.15
Reach1 1838 100 year 24 hour 521.00000 25.29 35.11 35.20 0.000426 3.07
320.25 53.09 0.17

Reach1 1664 1 year 24 hour 280.00000 23.00 26.72 26.48 27.64 0.014549 9.07
49.68 22.05 0.86
Reach1 1664 2 year 24 hou 374.00000 23.00 27.01 27.01 28.30 0.018895 10.90
56.14 23.00 0.99
Reach1 1664 10 year 24 hour 558.00000 23.00 34.02 34.14 0.000583 3.85
301.63 49.34 0.21
Reach1 1664 100 year 24 hour 781.00000 23.00 34.90 35.08 0.000813 4.80
347.10 53.64 0.25

Reach1 1489 1 year 24 hour 280.00000 20.40 23.48 23.48 24.66 0.019666 9.31
39.17 18.90 0.97
Reach1 1489 2 year 24 hou 374.00000 20.40 26.28 26.63 0.002700 5.42
107.71 30.20 0.40
Reach1 1489 10 year 24 hour 558.00000 20.40 34.01 34.07 0.000180 2.48
537.28 112.57 0.12
Reach1 1489 100 year 24 hour 781.00000 20.40 34.90 34.98 0.000248 3.04
650.04 137.67 0.14

Reach1 1263 1 year 24 hour 280.00000 17.06 21.77 21.79 0.000308 1.59
362.00 134.59 0.13
Reach1 1263 2 year 24 hou 374.00000 17.06 26.51 26.51 0.000021 0.66
1283.71 252.12 0.04
Reach1 1263 10 year 24 hour 558.00000 17.06 34.05 34.05 0.000003 0.35
3591.62 341.56 0.02
Reach1 1263 100 year 24 hour 781.00000 17.06 34.95 34.95 0.000004 0.46
3904.33 351.12 0.02

Reach1 942 1 year 24 hour 539.00000 14.00 21.73 21.74 0.000119 1.39
759.95 135.72 0.09
Reach1 942 2 year 24 hou 723.00000 14.00 26.50 26.50 0.000035 1.04
1517.05 194.23 0.05
Reach1 942 10 year 24 hour 1247.00000 14.00 34.04 34.05 0.000012 0.83
3393.72 258.07 0.03
Reach1 942 100 year 24 hour 1833.00000 14.00 34.94 34.95 0.000020 1.13
3625.69 258.07 0.04

Reach1 700 1 year 24 hour 539.00000 13.20 21.59 21.68 0.000534 3.13
329.33 66.58 0.19
Reach1 700 2 year 24 hou 723.00000 13.20 26.45 26.48 0.000130 2.10
724.23 92.44 0.10
Reach1 700 10 year 24 hour 1247.00000 13.20 34.02 34.04 0.000053 1.81
1468.19 99.32 0.07
Reach1 700 100 year 24 hour 1833.00000 13.20 34.90 34.94 0.000097 2.52
1555.30 99.32 0.10

Reach1 654 1 year 24 hour 548.00000 10.56 21.36 15.23 21.62 0.001890 4.11
150.58 32.65 0.24
Reach1 654 2 year 24 hou 734.00000 10.56 26.39 16.15 26.47 0.000426 2.61

425.25 69.67 0.12
Reach1 654 10 year 24 hour 1263.00000 10.56 34.00 18.40 34.03 0.000129 1.91
1135.19 121.37 0.07
Reach1 654 100 year 24 hour 1856.00000 10.56 34.87 20.87 34.93 0.000221 2.56
1240.55 121.37 0.09

Reach1 595 Culvert

Reach1 431 1 year 24 hour 548.00000 9.56 14.10 13.98 15.38 0.016405 9.23
67.93 33.54 0.83
Reach1 431 2 year 24 hou 734.00000 9.56 14.78 14.74 16.21 0.015411 9.97
93.09 40.01 0.82
Reach1 431 10 year 24 hour 1263.00000 9.56 16.18 16.18 17.94 0.014711 11.64
158.37 54.71 0.84
Reach1 431 100 year 24 hour 1856.00000 9.56 17.70 17.70 19.24 0.010948 11.68
276.80 91.93 0.75

Reach1 295 1 year 24 hour 548.00000 8.70 12.23 12.04 13.18 0.014618 8.44
86.41 41.30 0.84
Reach1 295 2 year 24 hou 734.00000 8.70 12.53 12.53 13.89 0.018676 10.15
99.61 46.23 0.97
Reach1 295 10 year 24 hour 1263.00000 8.70 14.02 14.02 15.00 0.010331 9.62
261.58 135.91 0.77
Reach1 295 100 year 24 hour 1856.00000 8.70 14.69 14.69 15.79 0.010937 10.78
357.40 148.23 0.81

Reach1 92 1 year 24 hour 548.00000 7.48 10.28 10.08 10.54 0.010017 5.53
211.94 209.30 0.66
Reach1 92 2 year 24 hou 734.00000 7.48 10.53 10.24 10.80 0.010017 5.94
263.51 213.97 0.67
Reach1 92 10 year 24 hour 1263.00000 7.48 11.09 10.70 11.41 0.010002 6.82
386.83 222.82 0.69
Reach1 92 100 year 24 hour 1856.00000 7.48 11.61 11.04 11.98 0.010004 7.58
503.30 230.49 0.71